 IN TWO SECTIONS—SECTION ONE

MECHANICAL ENGINEERING

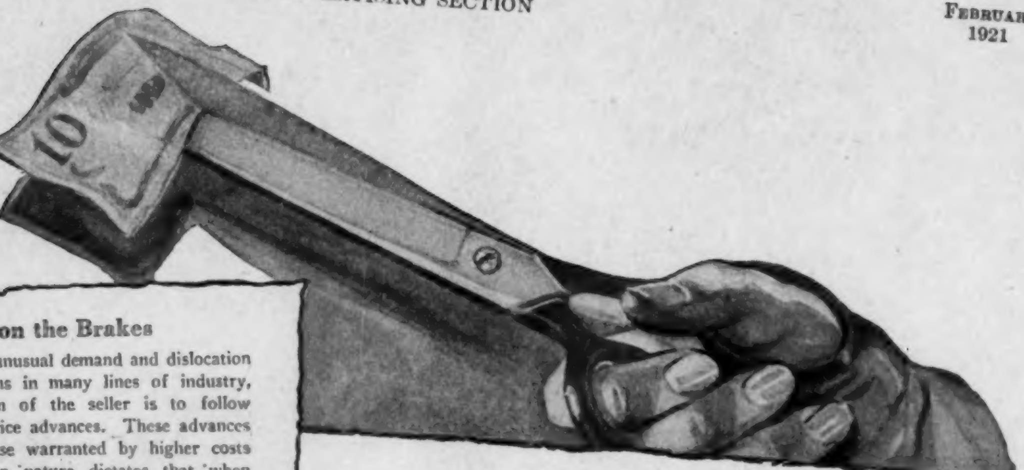
INCLUDING THE ENGINEERING INDEX

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

IN THIS NUMBER

FEBRUARY ·1921

THE MONTHLY JOURNAL PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS



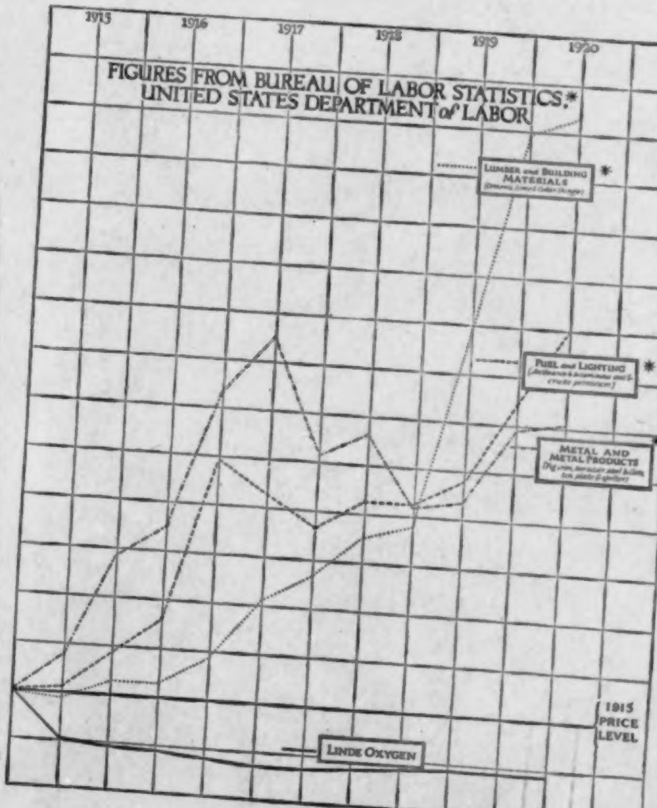
Putting on the Brakes

IN THESE days of unusual demand and dislocation of normal conditions in many lines of industry, the natural position of the seller is to follow a line of progressive price advances. These advances usually far exceed those warranted by higher costs of production. Human nature dictates that when a market is completely in the hands of the seller, as it is in many raw or manufactured materials at the present time, the obvious course is the most advantageous one, namely, that the price should be all that the traffic can bear.

Sound business policy frequently runs counter to natural impulses. Understrained price advances, no matter if the continuing demand appear to be so strong as to justify them, eventually reach the point where they shut off buying for the reason that the ultimate consumer cannot stand the cost. There is a maximum point beyond which to advance prices is to impose an undue burden upon one party and to threaten the good of the whole trade, since, after all, the best interests of buyers and sellers are interdependent. Large steelmakers are giving due recognition to this truth by throwing their influence against any further general advances in their lines of manufacture.

The wisdom of holding prices in check when radical advances are possible admits of ready recognition. To reduce them under present conditions, however, represents a much more striking example of broad-gaged business management. This is the policy which the Linde Air Products Co., leading manufacturer of oxygen, has had in effect since the beginning of the war. This company bases its action upon the belief that, in the long run, the good will and friendship that will accrue will more than offset any increased profits to be gained from higher prices in a temporary market. The practical results netted by such a policy, approaching as it does the altruistic in business, no doubt will be watched with keenest interest by the general manufacturing world.

from the **IRON TRADE REVIEW**
May 18, 1916



A policy, an editorial and a chart

DURING the days of war when things were being turned upside down The Linde Air Products Company maintained its standards of uniformly pure quality, comprehensive service and *low price.*

While prices of other essentials were mounting up towards the peak the average price of Linde Oxygen was reduced, and, through the most trying period of the war, continued practically on an even keel. This splendid record was made possible by the great volume of business accorded to Linde by manufacturers and other oxygen users the country over.

A continuation of this generous patronage will enable Linde to make more effective its unchanged policy of supplying American Industry with oxygen of the highest purity, anywhere, in any quantity and at the lowest possible price.

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Carbide and Carbon Building, 30 East 42nd Street, N. Y. — Balfour Building, San Francisco

The Largest Producer of Oxygen in the World

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Mechanical Engineering

The Monthly Journal Published by

The American Society of Mechanical Engineers

Publication Office, 207 Church Street, Easton, Pa. Editorial and Advertising Departments at the Headquarters of the Society, 29 West Thirty-ninth Street, New York

VOLUME 43 FEBRUARY, 1921 NUMBER 2

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Price 40 Cents a Copy, $4.00 a Year; to Members and Affiliates, 30 Cents a Copy, $3,00 a Year. Postage to Canada, 50 Cents Additional; to Foreign Countries, $1.00 Additional.

Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on January 17, 1921.

Contributors and Contributions

Woodworking Industries to the Front

Something over a year ago Mr. Thomas D. Perry, a member of the A.S.M.E. in the woodworking industry at Grand Rapids, Mich., called at Headquarters to express the interest felt by the group of members in that city in the engineering activities of the Society, and the belief that it would be mutually beneficial if attention were directed to the problems incident to the woodworking industry. The interest thus displayed was very promptly reciprocated and the engineers of the woodworking industry were asked not only to arrange a session for the Annual Meeting of 1920, but were later encouraged to join with others interested in forming one of the Professional Sections of the Society. In Mechanical Engineering for August, 1920, Mr. Perry contributed an article on The Engineer and the Woodworking Industry, outlining the urgent need for engineering skill in this field and indicating some of the problems encountered.

Thomas D. Perry

The Annual Meeting session was held and was an unqualified success. The leading article in this number is the report of this session, at which six papers were presented, all of exceptional interest, together with a remarkable series of lantern slides made available through the courtesy of *Lumber*, Weekly, of St. Louis, Mo., which constitute the pictorial features of the report. None looking over these illustrations can fail to be impressed with the degree of engineering skill already obtaining in the lumbering and woodworking industry, in spite of Mr. Perry's urgent call for the assistance and coöperation of engineers of the profession.

Analysis of Scientific and Engineering Work of the Government

At one of the recent meetings of the Washington Section of the A.S.M.E., Dr. E. B. Rosa, chief physicist of the Bureau of S andards, presented a review of what the Government is accomplishing in engineering and scientific work through its various bureaus, what it costs to do it, and answering, so far as possible, the question, "Does it pay?" His paper is published this month, complete, and is most informative. It turns the searchlight on Government expenditures, but this is done in a constructive and helpful rather than in a critical manner. The engineers of the country, through their organization of The Federated American Engineering Societies, have expressed as never before their desire to keep in touch with public affairs; and here, just as the Federation is beginning to function, is an article which gives important basic facts on the proportion of expenditures which goes for the civil side of the Government's activities and its public works, constituting what is in effect a first course in governmental affairs. It is an article which every public-spirited engineer will wish to read.

E. B. Rosa

Power Supply on an Economic Basis

It has become evident that consideration of power development for the great industrial districts of the country must be on the basis of greater economy in the use of fuel and in the distribution of the power to the points where it is to be used. This subject was broadly discussed at the last Annual Meeting of the A.S.M.E. by Col. John Price Jackson, formerly professor of electrical engineering at Pennsylvania State College and Commissioner of Labor and Industry of the State of Pennsylvania. His paper on The Policies for Future Power Development, printed in this number, shows how acute the power problem is in this country and in England, and how the demand for power may be met economically by interconnecting the large power plants in a given district, comparable to the service which would be rendered if the entire district were operated by a single power company. The public relationship which must be established and the financial considerations are also discussed.

This paper is followed by a second paper presented at the Power Session which discusses the Factors Affecting Steam-Station Costs, Particularly the Load Factor. This is by Peter Junkersfeld, of Stone & Webster, Inc., Boston, who has had long experience in power-plant operation, particularly with the Commonwealth Edison Company of Chicago.

Miscellanea

Dr. Charles E. Lucke discusses editorially the Diesel-engined motorship.

The final merging of Engineering Council into American Engineering Council of the F.A.E.S. is announced.

Machine-shop men will be interested in the questionnaire on machined fits just issued through a subcommittee of the American Engineering Standards Committee, in an attempt to formulate practice and to establish standards for plain limit gages.

In the Survey of Engineering Progress, as in recent months, long abstracts are given of the most important engineering articles and reports of the month, in addition to the usual short abstracts covering engineering literature generally. Notable among these in this number is the discussion of tidal power, now assuming prominence in England.

1921 A.S.M.E. Spring Meeting

Congress Hotel, Chicago, Ill.

May 23–26, 1921

The Professional Sections having gained headway at the Annual Meeting, are planning valuable sessions at the Spring Meeting.

Section Two of this issue contains the account of the Conference of Local Sections Delegates at the 1920 Annual Meeting.

MECHANICAL ENGINEERING

Volume 43 February, 1921 Number 2

Engineering in the Woodworking Industries

A Group of Papers Presented at the Annual Meeting of the A.S.M.E. Dealing with Furniture Manufacture, Freight-Car Construction, Machining of Railroad Cross-Ties, Wood-Block Floors, Wood Preservation, and Electrically Driven Sawmills

ONE of the most enthusiastic sessions held during the last Annual Meeting of The American Society of Mechanical Engineers was that on Forest Products, under the auspices of the newly formed Committee on Woodworking composed of Thomas D. Perry, Chairman, C. E. Paul, and Grant B. Shipley. As a result of the interest aroused by the session a petition was addressed to the A.S.M.E. Committee on Professional Sections requesting the formation of a Forest Products Section which might coöperate with similar organizations to the mutual benefit of the various woodworking industries.

As a general introduction to the session Frederick F. Murray, director of the department of mechanical engineering of the staff of *Lumber*, presented a strikingly interesting photographic study of the methods employed in logging and in the manufacture of lumber. This covered in brief form the various steps in logging and in the production of lumber at the mill. He also touched upon the utilization of wood waste. A selection of the photographs shown by Mr. Murray, tracing the steps of production from the cutting of the tree in the forest to the storing of the finished product in the lumber yard at the mill, ready for shipment, is given on this and succeeding pages in Figs. 1-27.

Following Mr. Murray's study the six papers scheduled for the session were presented. The first of these papers, Engineering in Furniture Factories, by B. A. Parks, pointed out some of the influences which have militated against the development of the woodworking industry and discussed the general principles involved in the design and layout of a new furniture-manufacturing plant. The Use of Wood in Freight-Car Construction, by H. S. Sackett, considered the relative values of steel and wood as materials for the construction of freight cars. Machining Railroad Cross-Ties, by D. W. Edwards, described the machines employed and processes followed in the machining of ties by trimming, adzing, boring and branding. Creosoted Wood-Block Factory Floors, by Lambert T. Ericson, described methods which will permit engineers to specify and build creosoted wood-block floors without entailing any risk of their failure. Processes and Equipment Used in Wood Preservation, by E. S. Park, dealt briefly with the different processes of pressure treatment. Electrically Driven Sawmills, by Allan E. Hall, set forth the advantages of motor-driven mills. Abstracts of all of these papers follow.

Photo by *Lumber*, weekly, St. Louis, Mo.

Fig. 1 From Forest to Finished Product—The First Step. No Mechanically Operated Device has yet Superseded the Hand Saw for Felling the Larger Trees

ENGINEERING IN FURNITURE FACTORIES

By B. A. Parks,[1] Grand Rapids, Mich.

THE woodworking industry is one of the oldest industries extant, and yet it has shown the least development and has been the slowest to adopt modern principles of manufacturing of any industry of which the writer has knowledge. There are several causes for this condition, the most important of which are the general lack of accurate cost data and the absence of technically trained men in the executive positions.

In several plants which have come under the writer's notice, only such repairs have been made as were necessary to avoid actual breakdowns, and machinery, power-plant equipment, lighting, heating, drying, sanitary facilities, etc., have been entirely inadequate and inefficient and would not be tolerated in even the average modern plant of most other industries. Also in the several woodworking and furniture-manufacturing plant organizations that have come under the writer's observation, he does not recall a single man with a technical education or training.

This lack of engineering ability in the furniture-manufacturing organization shows its effect throughout the entire plant; in fact, the writer is convinced that the average manager of a furniture plant is more interested in marketing his product than in manufacturing it.

The efficiency of any general plan for a furniture-manufacturing plant, or in fact any industrial plant, may be measured by the degree in which the following requirements are fulfilled:

(*a*) Provision for proper arrangement of the necessary machinery

[1] Mechanical Engineer, Byron E. Parks & Son, Assoc.-Mem.Am.Soc.M.E.

(b) Provision for receiving, handling, storing, and transporting material
(c) Provision for extending the plant and increasing manufacturing facilities without serious disturbance to the original plant or manufacturing routes
(d) Provision for generation and transmission of power, light and heat
(e) Provision for fire protection
(f) Provision for comfort and accommodation of employees.

Location

The importance of the location and arrangement of a furniture factory has not generally received the attention their economic value should dictate. The furniture industry, the same as other industries, has tended to concentrate in given localities, as, for example, Grand Rapids, Mich. This concentration was originally due to nearness to the raw-material supply. As the number of plants multiplied a good supply of skilled labor has accumulated, so that now, even when Grand Rapids is not so well situated as other centers as regards nearness to raw-material supply, the labor market as well as a certain reputation attaching to Grand Rapids product has tended to increase the number of furniture-manufacturing plants in spite of the fact that, theoretically at least, other centers would be more desirable from most standpoints. In general, however, the location of a furniture plant, as for most other types of manufacturing, will be dependent on the following considerations:

(a) Transportation facilities for both raw material and finished product
(b) Availability of raw materials and manufactured parts obtained from other industries
(c) Labor supply
(d) Financial considerations
(e) Civic or municipal aids or restrictions to manufacturing.

Provision for Proper Arrangement of Machinery

Making provision for the proper installation and arrangement of the necessary tools and machinery presupposes that the kind, quantity, and quality of the product have been decided upon and that due and proper care has been given to the selection of the machinery required in the manufacture of this product. Naturally the first consideration is the location of the lumber yard and dry kilns in relation to the incoming lumber to the factory. The location of the lumber yard will of course depend on the arrangement of railroad sidings. Several different plans for location of sidings may be possible for any given site and the most efficient layout can be determined only by close study of the factors entering into any given situation.

After deciding on the location of lumber yard and kilns this will ordinarily determine the point of entrance for the raw lumber into the proposed plant, and the next procedure will be to make a routing chart and thus establish the amount of floor space required for manufacturing purposes.

Having determined the entry point for the raw material, consideration should be given to each factory operation with the sequence required for manufacturing the product. The routing chart should list each separate part entering into the finished product, with the proposed volume of manufacture per unit of time, say, one year, and the sequence of operations required. Such a routing chart giving the sequence of operations will establish in a general way the sequence or arrangement of the various tools and machines throughout the plant.

After a tentative arrangement of the equipment has been completed a careful study should be made of how the product is to be transported from machine to machine, making proper provision for aisleways and location of trucks at machines to allow of efficient handling of material in and out of machines. The final arrangement will determine the amount of floor space required for machine rooms, and careful consideration should then be given to the location and size of store rooms, assembling, finishing, upholstering, crating, and shipping departments, factory offices, toilets, locker rooms, etc. With the approximate total amount of floor space decided upon, a tentative layout of the building may be made. The product of a furniture factory being comparatively light in weight, and consequently easily transported, a multi-storied building will in most cases be found the most economical from all standpoints, although four or five stories in height should probably be the the limit. The various departments may then be arranged with machine room and shipping department on the first floor, additional machine room if required on the second floor, and assembling, finishing and upholstering departments on the upper floors, care being exercised to so arrange the various departments that the flow of product may be as direct and uninterrupted as possible through each department and then on to the next.

Upon completing the arrangement of the various departments the next problem will be one of transportation between the several departments on the different floors, which is accomplished ordinarily by means of elevators. In connection with the transportation problem, thought should be given to the possibility of using chutes, conveyors, or small elevators from one department to another, thus establishing more direct paths of flow than could be obtained by using the main elevators and also reducing considerably the amount of handling required.

The floor space and general arrangement of the main manufacturing building having been determined, the next decision to be made is the type of construction to use. This is somewhat limited to materials available, although in most centers where a furniture factory is likely to be built the ordinary forms of construction such as reinforced concrete, slow-burning mill, or steel frame, will be found applicable. Reinforced concrete is rapidly coming into use as one of the most economical types of construction, when all factors are considered, and yet the writer regards the slow-burning, heavy-mill type of construction as particularly adaptable to a furniture factory.

Provision for Handling and Transporting Material

One of the most important problems confronting the furniture manufacturer is the receiving, handling, storing, drying, and transporting of the raw material, namely, lumber. Much thought and study should be placed on the arrangement of sidings, storage yards, dry kilns, cut-off saws, etc., as an efficient layout will pay for its development many times over in decreased labor and saving in time.

The lumber storage yard should be large enough to at least hold a year's supply in order that advantage may be taken of favorable market conditions. The storage yard should also be equipped throughout with industrial trackage laid parallel with the receiving siding. This trackage system should be served by at least two transfer tracks running at right angles to the receiving siding. With this arrangement lumber is unloaded and sorted directly on small lumber trucks or "bunks" of the ordinary kind and then by means of the transfer tracks the truck loads, containing about 4000 ft., are placed in storage ready to be taken to the kilns for drying.

The type of kiln used will depend on the thickness and kind of stock to be used. A dry-storage shed equipped with industrial trackage is also valuable as it allows for an accumulation of dry material and thus avoids delays in receiving lumber at the cut-off saws which might be occasioned by accidents to the kilns, stock spoiled in process of drying, or other delays between the kilns and the mill.

The same system of transfer tracks that serves the storage yard and kilns should be extended to the cut-off saws, where there should be provided hydraulic or screw lifts or elevators to raise the entire load of lumber and keep the top of the pile a few inches above the tops of the saw tables. It will be seen that with the above arrangement the lumber is not handled from the time it leaves the railroad car until it is placed on the table of the cut-off saw, and the consequent decrease in handling costs is at once apparent.

While the receiving and handling of the lumber should probably receive the greatest consideration in laying out the transportation facilities to and from the plant, yet railroad sidings to the power plant, for the delivery of machinery and coal, and to the shipping room for shipping the finished product, should not be overlooked but should receive thoughtful study.

Provision for Generation and Transmission of Power, Light, and Heat

On account of the large amount of refuse from most furniture

Photos by *Lumber*, weekly, St. Louis, Mo.

Figs. 2–7 From Forest to Finished Product—Getting the Logs out of the Forest

Fig. 2—Douglas fir in the State of Washington, showing characteristically rugged surroundings. Fig. 3—Logging railroad penetrating forest in wake of surveyor's transit. Fig. 4—Special construction cars for placing of ties and laying of rails. Fig. 5—Logs being dragged in by overhead cableway system. Note loading boom to left of mast and way in which entire machine to right is jacked up so empty log cars can pass under. The empty cars are run in and the first one is loaded, when the loader itself pulls out the next car, and so on until the load is completed. This is one of the many applications of the "sky line" method. Fig. 6—Crawler-type tractor, capable of doing work of 16 or 18-mule team, and also of working in soft ground. Fig. 7—Heavy-duty truck and two-wheel pole trailer used extensively in western motor-truck logging, showing characteristic load of about 3000 ft., log scale, and weighing from 4½ to 5 tons.

factories, which is available for fuel, it follows without much argument that in by far the majority of cases it will pay to erect an isolated power plant, unless capital is limited or the plant be very small.

The first decision to be made in starting the power-plant design is the method of transmitting power to the various machines in the factory. In by far the majority of cases the most efficient method of transmitting power from the prime mover to the principal machines in small and medium-sized plants is by means of shafting, pulleys, and belts. Electric individual or group driving of machinery is unquestionably the best and most economical where machinery is widely scattered, or where some of the machinery is operated only part time, but where most of the machinery may be arranged in one department and the majority of it is operated at all times, the initial expense and overall efficiency of driving from lineshafting take precedence over those of electric drive.

Upon deciding on the method of transmitting power to the various machines the next step will be to select the proper type and capacity of prime mover. The load factor in most furniture plants will average from 75 to 80 per cent of the connected load. An estimate must then be made of the power consumed by power-transmission equipment, consisting of shafting and belts or electric drives, and by adding the connected load, corrected for load factor, plus an allowance for mechanical efficiency of the prime mover, the indicated-horsepower capacity required to furnish the plant with power may be determined. The electric load and lineshaft load should of course be kept separate in order to determine the generating capacity required, also the electric lighting should be laid out and proper allowance be made both in the generator and prime mover.

The low-pressure steam requirements for dry kilns, heating, etc., should be determined and a curve drawn showing the average demand for low-pressure steam throughout the year. Assuming a steam consumption of 26 or 27 lb. of steam per indicated horsepower per hour for the ordinary Corliss type of engine and that 85 per cent of the exhaust will be available for heating and drying purposes, a curve should next be drawn showing the average available exhaust steam for the various months of the year, and upon comparing the two curves it will be seen at a glance during which periods of the year the heating and drying demands exceed the exhaust from the engine, or vice versa.

In most furniture plants the exhaust from the engine will exceed the requirement for low-pressure steam during the summer time and it therefore becomes a question as to how valuable this excess of exhaust steam is and how great an investment is warranted in cutting it down to the minimum. From a knowledge of the total steam requirements of the plant the amount of fuel required can be calculated, assuming that 20 to 25 per cent of the lumber cut finds its way to the boiler room as refuse or waste, and that the fuel value of the wood is about 20 per cent of that of the average bituminous coal, weight for weight. It is then a simple calculation to determine the cost of evaporating the excess of exhaust steam during such periods of the year as this excess exists. Any saving effected by reducing the amount of the excess exhaust steam, which would go to waste, should not only pay all fixed charges on any investment made to reduce this excess, but should also pay a return of at least 20 per cent per year on this additional investment. The type of engine best suited for driving a lineshaft load where efficiency, economy and continuous operation are permanent considerations is probably the slow- or medium-speed releasing-gear simple Corliss engine or the poppet-valve engine, which latter is similar in most respects to the Corliss except in the valve gear.

In choosing boilers for the plant the capacity required may be determined from the total steam demand, adding an allowance of 10 to 15 per cent for pumps and other incidental uses throughout the plant. By dividing the total maximum boiler capacity required into at least three units it will always be possible to operate the plant on two boilers, for even with a maximum demand for steam two boilers will carry the plant by operating at 150 per cent of rating.

The location and arrangement of the power plant are important as regards the economical transmission of power to the factory and the allowance for increase in capacity. Where lineshaft drive is used the power plant is located in a separate building, preferably near the center of the main lineshaft, though of course within easy driving distance from engine shaft to main receiving shaft. This location of power plant is also fairly near the center of distribution for steam and electric current.

The utilization of the factory waste or refuse so as to obtain the maximum fuel value is another problem which should receive its fair share of thought and study. Of course, shavings and sawdust from the various machines will be handled by an exhaust system to a separator on the boiler-house roof and then spouted to the boilers or shavings vault. In most plants the cuttings and culls are collected in push carts by a crew of men and wheeled to the boiler house where they are fed to the furnaces by hand. The above method of handling this part of the refuse is not only expensive from the standpoint of handling cost, but the full value of the refuse as fuel is not realized due to the manner of firing. The installation of a few small "hogs" or chippers, at convenient points in the plant where cuttings collect, discharging into the regular exhaust system will in many cases be found to be a paying investment. The power consumption is considerable and a certain amount of maintenance is required, but these disadvantages will frequently be found to be outweighed by the decreased labor cost and the increased efficiency obtained in burning the fuel.

Another improvement in the handling of refuse is in regard to feeding the excess shavings and sawdust which ordinarily are allowed to collect during the day in a so-called shavings vault. In most plants the contents of the shavings vault must be fed to the furnaces with a shovel, which is not only laborious but prevents the full fuel value being realized. In the design of a power plant for a woodworking factory for which the writer was partly responsible, overhead bins were installed instead of the customary shavings vault. These bins fed by gravity to a short length of screw conveyor discharging into the furnace fronts, a separate conveyor being provided for each boiler. The speed of the conveyors could be varied by means of a friction drive, thus allowing the quantity of shavings and sawdust fed to the furnace to be regulated in accordance with the load on the boiler.

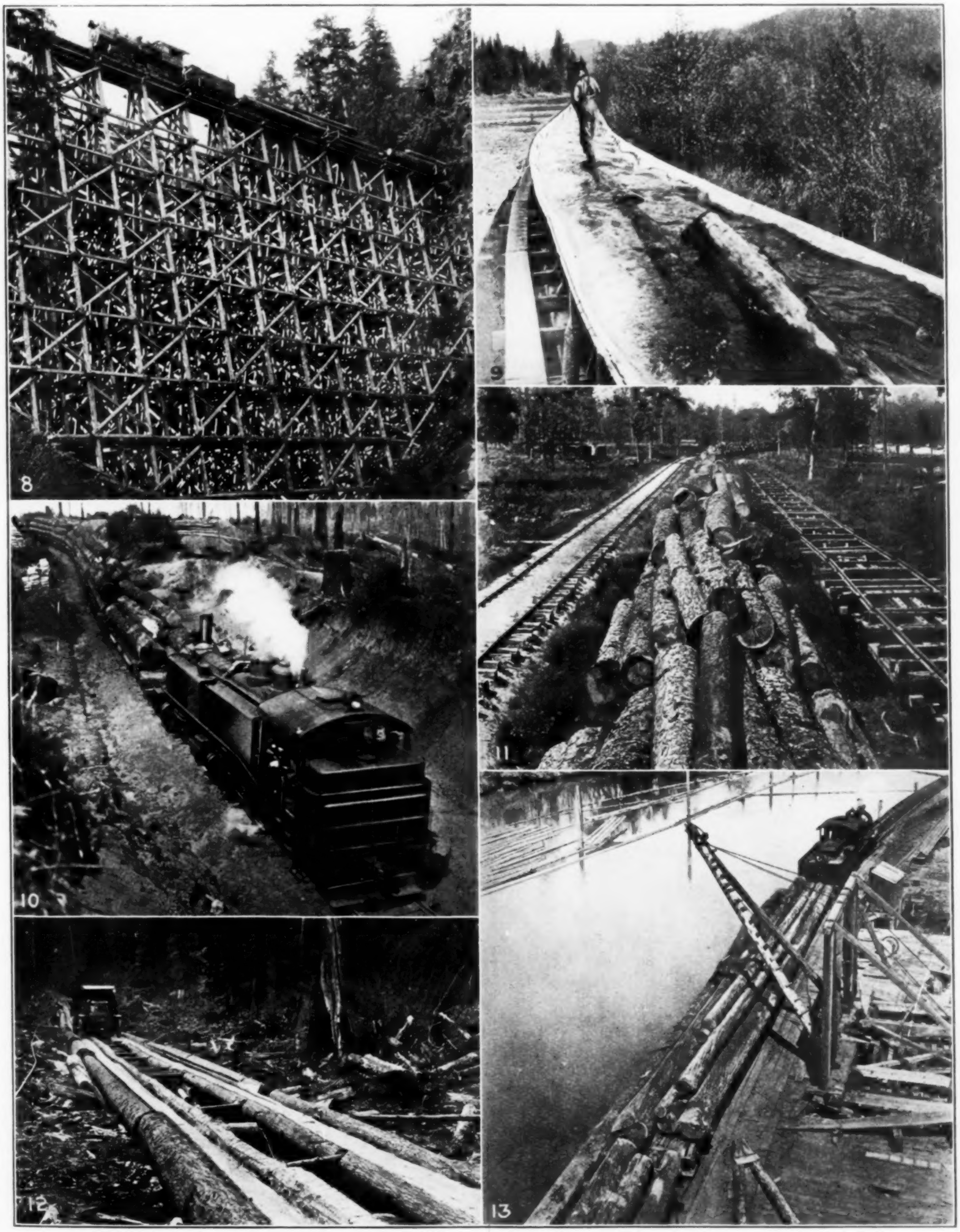
Fire Protection

In a woodworking establishment the fire hazard is naturally much greater than in a metal-working plant, consequently more than ordinary care should be exercised in decreasing the fire hazard to a minimum and preventing the spread of fire in case it does start. Buildings should probably not exceed 250 to 300 ft. in length without dividing them by suitable fire walls at least 17 in. thick, and extending well above the roof line. Finishing and upholstering departments should if possible be isolated from the rest of the plant by fire walls, and if they are on upper floors and any great distance from stairways, outside fire escapes should be provided.

All stair wells and elevator shafts should be enclosed in fireproof towers, and to make fire walls and fireproof towers effective all openings should be fitted with automatic fire doors. It is also well to note that all stairs should be of non-combustible material so they cannot be destroyed in case fire is communicated to the stair well itself. All sash should be steel and the windows opposite adjacent buildings, where buildings are 30 ft. apart or less, should be glazed with wire glass. It almost goes without saying that a good sprinkler system should be installed throughout the entire plant with plenty of yard hydrants and a good supply of fire hose. All motor-control switches should be enclosed in steel boxes so arranged that the box cannot be opened when the switch is closed. All switches for motors driving spray-booth fans, or for motors in other locations where inflammable gas or dust is prevalent, should be of the remote-control type enclosed in tight steel or iron cases, with a push button near the booth or other machine. Spray-booth fires are a constant source of danger and the method above mentioned of controlling the fan motors is well worth the investment required.

Proper Accommodation for Workers

Under accommodations for workers may be included the lighting, heating, toilet, and locker-room arrangements of the plant. The day of the dark, poorly heated and ventilated factory building with inadequate and unsanitary toilet facilities is past, for the simple reason, if for no other, that any self-respecting man will



Photos by *Lumber*, weekly, St. Louis, Mo.

Figs. 8–13 From Forest to Finished Product—Transporting the Logs to the Mill

Fig. 8—Trestle on logging railroad in Oregon. The structure is 525 ft. long, 160 ft. deep and contains about 800,000 board feet of lumber. The bents are spaced on 15½-ft. centers and supported on some 300 piles driven to a penetration of about 30 ft. Fig. 9—Flume for carrying logs. Flume tender inspecting flume for log jams and leaks. Fig. 10—One of the best examples of modern logging locomotives, privately owned: a 100-ton Mallet with compound cylinders, 12 drivers, and oil burners. Operates over severe sections containing 5½ per cent grade and 26-deg. curves. Fig. 11—A southern log train being made up. The completed train consists of 52 cars for a 20-mile haul to the mills. Fig. 12—A hewn-timber road constituting a logging route for heavy-duty motor trucks, a practice developing for operation where the expense of railroading is not justified. Fig. 13—Logs awaiting unloading at the log dump. The load consists of full-tree-length logs as carried by disconnected log bunks, forward four-wheel truck and rear four-wheel truck having no connection other than the logs themselves.

Photo by *Lumber*, weekly, St. Louis, Mo.

FIG. 14 A CITY OF LUMBER AND SHINGLE MILLS. LUMBER BROUGHT IN IN FORM OF GREAT LOG RAFTS

not work under such conditions. Bright, cheerful surroundings, comfortably heated and well ventilated, are no longer regarded as an expense by the modern executive but as an investment which pays large returns in increasing production and quality of product, decreasing labor turnover and promoting contentment and loyalty among the employees.

The far-too-usual method of providing a drop cord with a bare lamp over each machine or at each workman's bench with a few thrown in for general illumination should not be tolerated in this day and age when good, efficient fixtures may be had at such reasonable cost. Where walls and ceilings are painted white with some good industrial enamel, efficient lighting may be obtained

Photo by *Lumber*, weekly, St. Louis, Mo.

FIG. 15 AN ELECTRICALLY OPERATED MILL ON THE PACIFIC COAST

Note concrete power house and stack; log-washing device to the left; dome-shaped refuse burner to right of stack.

through a proper selection of reflectors or fixtures at a comparatively small cost in power consumption.

With regard to heating, probably the most ideal system is the hot-blast, for such a system provides adequate ventilation as well as heat and in the summer time may be used to cool the air introduced into the factory by circulating cold water through the heating coils.

The toilet and locker rooms should be centrally located with regard to the building or floors which each serves, and preferably placed in a service wing, as already mentioned. By so locating these features valuable manufacturing space is not taken up and good light and ventilation may be obtained. Washing facilities should preferably consist of enameled roll-rim cast-iron sinks with no stoppers in the waste. Such equipment has the advantage that it is easier to keep clean than individual wash basins and forces the men to wash in running water, an important point in preventing the spread of disease. Every man in the plant should be provided with a pressed-steel locker where he may change his clothes, and the addition of a few showers and a comfortable, well-lighted room where the men can eat their lunches will be found to be not only conveniences provided by a generous management, but features which add still more to the contentment and loyalty of the men.

As mentioned before, these few notes are not intended as a treatise on the design of a furniture factory, but merely as a brief discussion of some points which the writer feels are worthy of serious consideration. The many factors affecting the design and construction of a plant are so important in their bearing on the final overall efficiency of the plant, that the problem is quite properly one for none but an experienced engineer.

THE USE OF WOOD IN FREIGHT-CAR CONSTRUCTION

By H. S. SACKETT,[1] CHICAGO, ILL.

THE fact that over two billion feet of lumber and timber are used annually in the United States for the maintenance of freight equipment and for the construction of new cars, representing an annual outlay for material alone of over $50,000,000, is ample evidence of the importance of wood in this big industry.

In the construction of the first cars wood was almost universally used for all parts, except of course the running gear. Within the

[1] Asst. Purchasing Agent, Chicago, Milwaukee and St. Paul Railway Company.

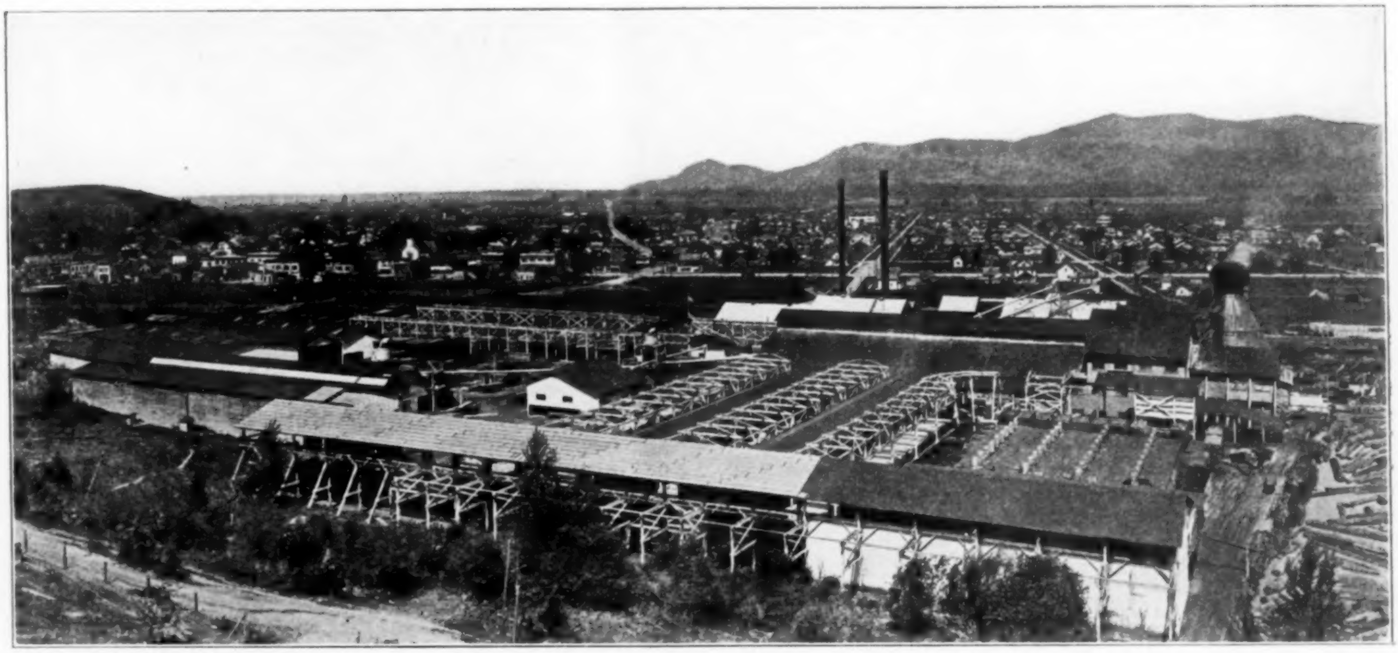


Photo by *Lumber*, weekly, St. Louis, Mo.

Fig. 16 Typical Large Sawmill Plant Including Dry Kilns, Planing Mill and Covered Storage

past decade, however, with the introduction of heavy motive power—which spells long and heavy trains—it has been found that wood is no longer capable of withstanding the heavy shocks incident to such operations, and it is generally conceded by all car builders that the freight car of the future must have a steel underframe and steel draft rigging.

This limits the use of wood to unimportant parts of the underframe, such as intermediate sills and cross-beams, and to the superstructure of the car. In the case of open-top cars this means only posts and side and end plank and decking, but in box, stock, and furniture cars, etc., it means also siding, lining and roofing.

Steel vs. Wood for Open-Top Cars

To take up the question of open-top cars first, statistics gathered by operating officials of some of the large railway systems seem to indicate that the cost of maintaining steel gondola cars over a period of years is greater than for composite (wooden and steel) cars of the same type. The data[1] collected show that all-steel gondola cars in their twelfth year of service cost over 36 per cent more to maintain than did the composite gondola. Of course, it is probable that during the first five years of its life the steel gondola cost less to maintain, but it is felt that taking the entire twelve years as an average, the cost would be more for the maintenance of the steel than the composite gondola.

It is furthermore interesting to note that but 60 per cent of the composite gondolas in service required repairs, while 72 per cent of the steel gondolas were obliged to be brought to the shops. The actual time that a car is in service and earning money for the road is an important consideration in determining its general utility.

A table in the complete paper shows that the annual cost of repairing freight cars has increased from $59.30 in 1908 to $80.30 in 1914, an advance of over 35 per cent. This higher cost is due, of course, to a number of factors, but it is felt that no small part of it is due to the use of steel, which requires a greater outlay for material and a higher cost to repair, owing to the fact that it takes longer to make like repairs on a steel car than on a wooden one. It must also be borne in mind that this higher cost is very largely due to the much rougher usage to which freight equipment is now subjected. In recent years the freight business of the railroads has grown enormously, and has necessitated the construction of gravity yards for switching, and the use of fewer switchmen per cars handled than in former years. This has resulted in severe handling of freight equipment, and is probably responsible to a greater degree than any other factor for the increased cost of repairs in recent years.

Steel vs. Wood for Closed-Top Cars

In the case of closed-top cars, such as, for example, stock, box, and furniture cars, there is but little doubt that under present railroading conditions the understructure should be of steel with a wooden superstructure. The steel understructure is required to withstand the shocks of service and to give rigidity and stability to the car, while the wood is desired to give lightness and general utility to the body. Some all-steel box cars are in use today, but

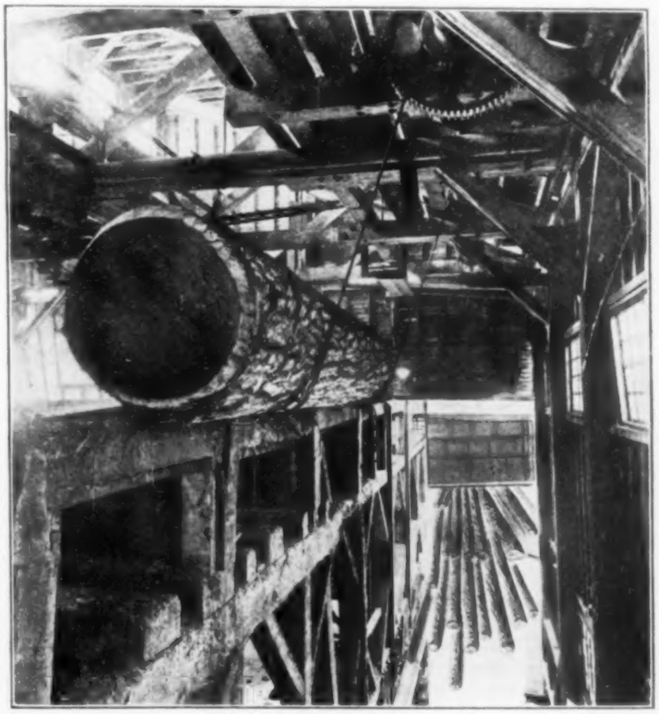


Photo by *Lumber*, weekly, St. Louis, Mo.

Fig. 17 Wire Rope Sling Haul-Up

Device carries log to the mill log deck where sawing operation starts. Medium-sized fir log 4 ft. in diameter shown.

[1] Paper by Wm. Queenan, Asst. Superintendent of Shops, C. B. & Q. R.R.

their heaviness and the fact that nails and cleats cannot be used in them to brace and hold the lading, are strong factors against the use of this material. It has not met with favor with shippers generally and probably will not as long as wood continues to remain available.

Graded Lumber in Car Construction

It seems pertinent to say a word at this time as to the grades of material required for the different parts of the body of the car. In the early days when the supply of wood in this country was thought to be inexhaustible, clear grades of wood were generally demanded by the car builders, and in the construction of new cars this is generally the practice at the present time, especially for car roofing and siding, sound-knotted stock being used for decking and lining. Some of the more progressive railroads, however, have gone a step further in recent years and many are now using sound-knotted stock for siding and roofing for repair and maintenance work. There is no doubt but what such a practice is economical and based on sound judgment, for certainly there is no necessity for using clear material for the repair of many classes of freight equipment, the life of which may not be in excess of seven to ten years. One large railway system which not only constructs its own cars but does repairing on a large scale, has adopted this practice and the saving amounts to over $500,000 per year.

An important feature of car construction which is decidedly in wood's favor, is its general ease of working and adaptability to repair, and this is brought about not only from its qualities which make it easy to cut, saw and shape, but also by its almost universal availability.

It is also rather curious that the salvage value of wooden cars is greater than that of steel cars, and no one doubts this who has seen the two types of cars in a seriously wrecked condition. The wooden car may be quickly and easily repaired, while the steel car is only rehabilitated at a high cost, or for the most part is fit for the junk pile.

The Importance of Well-Seasoned Wood

Before using wood in the building of freight cars it is vitally important that it be well seasoned. When our grandfathers built a house they expected it to last a century, and it usually did, for they took great care to properly season the wood before putting it to use. In the houses nowadays, however, we use wood almost before it is dry from the saw, and the result is that our American frame houses today are old at fifteen or twenty years. Too often today we also see freight cars built of green lumber and timber, with the result that within a few months the bolts are loose, the wood having shrunk away from the original fastenings. This causes rapid deterioration and large timbers often quickly rot, particularly those containing sapwood.

Increasing attention has been given in recent years to the preservative treatment of certain parts of freight cars, and experiments have been made by some of the more important railway systems in the treatment of such items as stock-car decking, side and intermediate sills, roofing, etc. While these experiments have not been conducted for a sufficient length of time to determine actual results, the indications are that the preservative treatment of such car parts as are particularly liable to decay is profitable and will shortly be adopted as standard practice by the more progressive railroads. The conclusion is inevitable that the superstructure of freight cars will continue to be of wood as long as it is available at a reasonable price.

CREOSOTED WOOD-BLOCK FACTORY FLOORS

By LAMBERT T. ERICSON,[1] TOLEDO, OHIO

THE use of creosoted wood blocks for factory floors has been so extensive during the past few years that it is hardly necessary to go into details in regard to the advantages of this type of flooring. Most engineers and architects have come in contact with this material at first hand, so that this paper will be confined to a discussion of (1) the material used; (2) the problems encountered; and (3) the field covered.

Southern yellow pine has been employed almost entirely for this work, except on the West Coast, where Douglas fir and tamarack are used. Long-leaf pine is usually specified, but short-leaf pine is also adaptable for the work. The lumber should be thoroughly air-seasoned before being cut into blocks, and then should be given a preservative treatment with coal-tar creosote oil to preserve the wood from decay. Hard woods, such as gum, beech, and maple, can be used, but they are not favored on account of the difficulty in properly seasoning the lumber and the tendency of the blocks to warp and check after they are cut. The coniferous woods are more homogeneous in grain and texture and are consequently more adaptable. Soft wood compacts under service and consequently it is just as serviceable as hard wood, and has the advantage of not becoming slippery under traffic.

It should be understood in the beginning that factory flooring with creosoted wood blocks cannot be grouped under one general heading and specification. The conditions under which the floor is to be used must first be studied and the specifications made to suit. Creosoted wood blocks can be laid to meet practically all factory conditions if the conditions are first properly analyzed. The real reason for most of the trouble encountered with this type of flooring is the fact that wood expands and contracts with various conditions of the atmosphere and the moisture content of the blocks. It is therefore necessary to lay the individual blocks in such a way as to allow for this change in volume, which in extreme cases may be as much as 5 per cent. The individual units in the floor must be bound tightly in place with a binder which will allow this expansion and contraction and which will exclude water from the underside of the floor. As long as the blocks are held tightly and firmly in place and a smooth surface is maintained the floor will wear almost indefinitely, but as soon as they become loose and the surface rough they will break up into sticks very quickly.

Conditions to be Met in a Successful Installation

The three most essential requisites for success are: (1) thoroughly air-seasoned lumber; (2) a smooth, solid foundation base; and (3) a waterproof and elastic binder to hold the units in place. In the majority of cases factory floors are dry most of the time; consequently, the lumber should be thoroughly seasoned, in order to keep the shrinkage to the minimum. Blocks cut from green or semi-dry lumber will shrink in volume to such an extent that they will often have to be taken up and relaid. If it is possible to do so, it is advisable to use a concrete base for the installation of these floors. The base should be strong enough to carry the entire load and should be finished smooth and level so that it will not be necessary to use a cushion between the concrete and the blocks in order to secure a level floor and uniform bearing for the individual units.

Wherever a cushion is necessary between the concrete and the blocks, it is advisable either to use a mixture of portland cement and sand or a bituminous mastic. The latter is preferable in a great many cases on account of being both waterproof and elastic. It is standard practice today to lay the blocks directly upon a smoothly finished concrete without any cushion whatever. It is also customary to give the base a thin, even coating of coal-tar pitch before installing the blocks, so that the underside of the blocks may be thoroughly sealed and made waterproof.

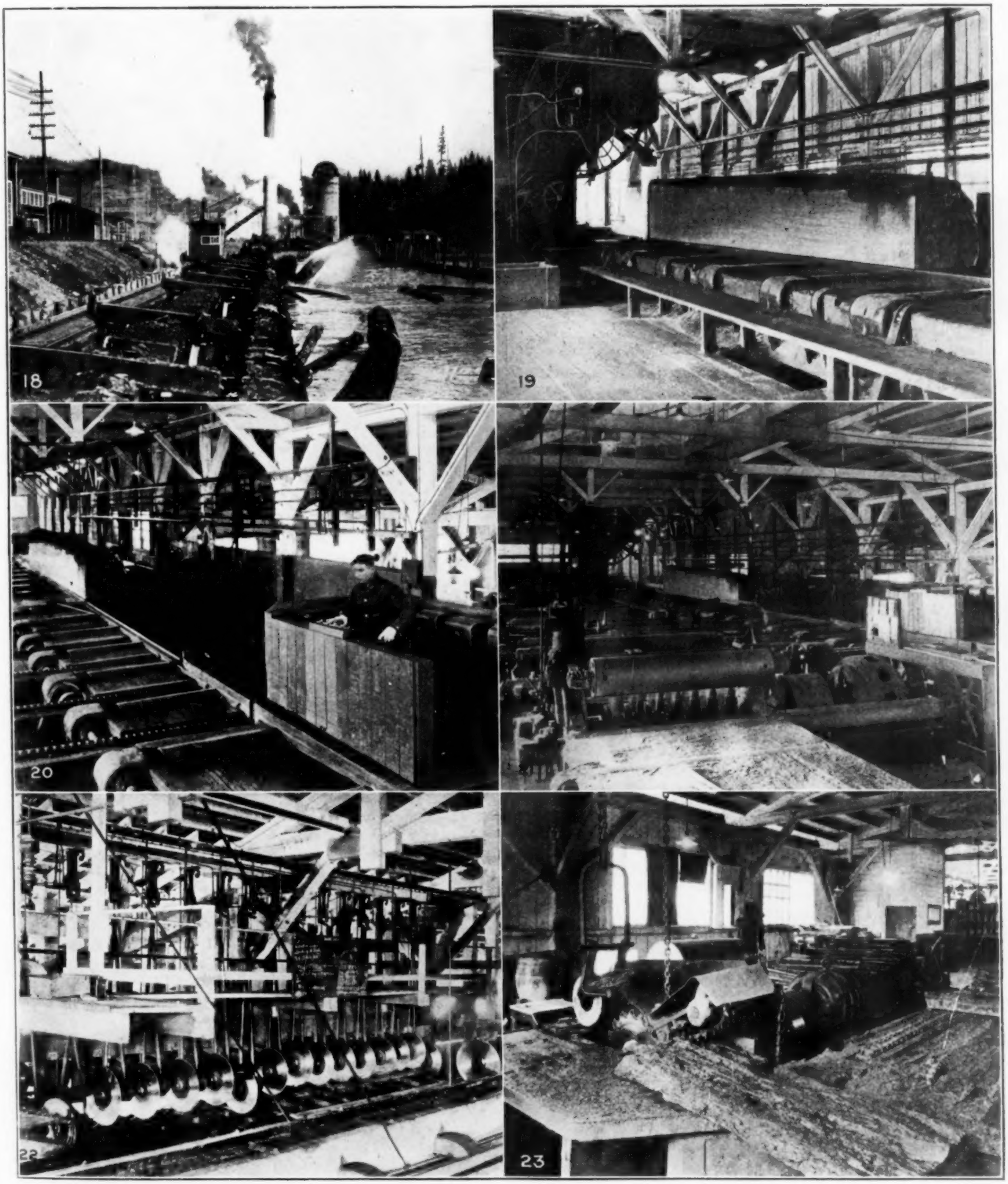
The elimination of cushions and the use of a successful waterproof binder in the joints of the blocks, thereby eliminating the possibility of shifting of the base and a loosening of the units, has permitted a reduction in the depth of the blocks used. Factory floors are now being very successfully installed throughout entire manufacturing plants with blocks as shallow as 2 in. in depth.

Successful installations may be made on timber and plank foundations in mill-type buildings, but care must be taken to see that the timber in the foundation is sound and that the blocks are afforded a firm and even footing. A bituminous-mastic cushion between the planks and the blocks is now being extensively used and is proving very successful.

The Uses of Wood-Block Flooring

Creosoted wood-block floors are being installed in machine shops, forge shops, foundry molding and core rooms, casting cleaning and

[1] Chief Engineer, The Jennison-Wright Company.



Photos by *Lumber*, weekly, St. Louis, Mo.

Figs. 18–23 From Forest to Finished Product—Converting the Logs into Lumber

Fig. 18—Dumping fir logs at large plant at Snoqualmie Falls, Wash. Skeleton log cars in foreground from which logs are unloaded by a special type of locomotive crane. Fig. 19—A characteristic band mill and large log. Band-saw wheels 11 ft. in diameter, band saw 14 in. wide, tooth speed about 10,000 ft. per min., maximum cutting rate approximately 800 sq. ft. of wood section per min. A 250–300-hp. motor is used for drive. Fig. 20—Steam-actuated cross-chains for routing material through mill, electrically controlled from a single station. Operator makes necessary changes by pressing buttons. Fig. 21—Edger machine for trimming lumber to width of standard-size plank. Adjustable saws are driven by electric motor. Motors as large as 400 hp. are used in this capacity, though average size is 100 to 150 hp. Fig. 22—Selective trimmer with pneumatic control cylinders and swing saws. Any one (or more) of the saws may be lowered into the cutting position by the compressed-air control to cut a board of required length. These trimmer saws are usually on 2-ft. centers; the lumber is fed into the machine on the carrier chains shown. Fig. 23—Wood conservation. Converting bark slabs into lath. The first machine or set of saws rips the slab into narrow strips, from which the laths are cut in a second machine.

Photos by *Lumber*, weekly, St. Louis, Mo.

Figs. 24–27 From Forest to Finished Product—At the Planing Mill and in Storage for Shipment

Fig. 24—Handling lumber at the planing mill on the rough or entrance side. The lumber is brought in in packages by means of a special crane and set upon power-driven rollers which feed directly into the surfacing machine. The monorail system carrying overhead crane and other devices perform this function. Fig. 25—The mechanical lumber piler known as the "Iron Swede" permits higher piles than possible by hand work. The machine is most conveniently electrically driven; some gas-engine applications exist. Fig. 26—Motor truck, used for mill shipment, being loaded by means of an overhead bridge crane at the sawmill plant. Fig. 27—Softwood piles, the lumber being stored for natural drying; served by industrial railroad with storage-battery locomotive.

chipping rooms, warehouses, leather and paper mills, automobile assembly plants, garages, loading platforms, etc. The conditions in the above work vary from extremely dry to a saturated moisture state. They also vary from low to high temperatures, and in some cases the blocks are submitted to the action of molten metal. The extreme variation in the demands covered by the above list of industries gives a fair idea why it is necessary to study the individual job at hand and draw a specification to meet the particular work.

For ordinary factory purposes the proper treatment for the blocks is 6 lb. of creosote oil per cubic foot of timber. This is injected by the Rueping process and is sufficient to preserve them from decay. When they are to be subjected to considerable moisture or to the weather, they should be treated with 12 lb. of oil per cubic foot of timber by a combination of the empty- and full-cell processes. This extra amount of oil insures better waterproofing of the blocks.

Floors which are to be subjected to considerable moisture, or to weather conditions, should be laid with ample provision for expansion. It is good practice to provide ample space between the individual units to take care of this expansion. These joints should be flushed full of a waterproof, elastic binder, which should preferably be coal-tar pitch of a consistency which will not soften up under atmospheric or room temperatures. Coal-tar pitch has proven the most successful binder and filler for creosoted wood blocks, as it is a derivative of the same base as creosote oil, and thus readily unites with the oil in the blocks.

ELECTRICALLY DRIVEN SAW MILLS

By ALLAN E. HALL,[1] MILWAUKEE, WIS.

The complete modern plant for the manufacture of lumber includes everything required to transform the growing tree into finished lumber ready for the builder; and this plant naturally divides into forest equipment and mill equipment. The forest equipment, which includes logging machinery and railroad and water transportation of the logs to the mill, is not considered in the present paper.

The capacity of a sawmill is regularly given in thousands of feet board measure per day of 10 hours. The power required for sawmill alone varies from $4^1/_2$ to 8 hp. per 1000 ft. of lumber per day; e.g., a sawmill of 100,000 ft. daily capacity will require from 450 to 800 hp. The lower figure is for mills cutting small and medium pine logs; the higher figure for Pacific Coast mills working the heaviest timber, or mills sawing hardwood. The planing mill will require from 2 to $3^1/_2$ hp. per 1000 ft. on the same basis. The total power for milling is therefore from $6^1/_2$ to $11^1/_2$ hp. per 1000 ft. board measure of lumber sawed per 10 hours.

Two things should be kept in mind in estimating and comparing power used in different sawmills: First, two sawmills rated at 100,000 ft. board measure per day each may deliver this 100,000 ft. in very different forms. The first may be a "board mill" and the entire day's cut may be 1-in. boards. The second may be a "timber mill" making 50 to 60 per cent of the logs it handles into timbers or large dimension pieces. It is obvious that one 12-in. by 12-in. by 16-ft. timber will add just as many board feet to the day's tally as 12 boards 1 in. by 12 in. by 16 ft., but the latter will have consumed much more power. Second, it consumes more power to saw hard, dense wood than to saw soft, light wood. Some mills work hardwood or softwood exclusively; others must cut various kinds just as they come, owing to the timber supply being of mixed varieties.

Conditions of the Problem

In deciding whether to drive a sawmill by lineshaft or motors, the first consideration is the probable life of the plant. Unlike most manufacturing plants, the sawmill must nearly always be built close to the supply of raw material; for it is not commercially possible to transport sawlogs far from where they grow, except in the case of valuable timber like mahogany and other tropical hardwoods. When the supply of accessible timber is sawed, the plant must be abandoned or moved with a very small salvage value. Sawmills which have a timber supply in sight to saw for twenty years or more form a small percentage of the total number. The first cost must therefore be kept down to a figure which can be wiped out from the profits in a few years—fifteen, ten, or even eight years—without making too great an annual charge.

The size of the sawmill plant is important. It is found that for very small mills the first cost of the electric power plant and motors is greater than for a steam plant and belted drive. For medium-size sawmills the first cost does not differ greatly when everything is considered; and for large plants the first cost may be less for a motor-driven than for a shaft-driven mill.

Accessory or by-product equipment will affect the choice between the two kinds of power transmission. As previously explained, the planing mill is considered as a part of the complete installation; but beyond this every intelligent lumberman is constantly trying to make the waste wood from his sawmill into useful products. As an example, a large mill recently built for the manufacture of yellow-pine lumber makes from waste wood (*a*) kiln sticks for spacing lumber in the dry-kiln stacks, (*b*) lath, (*c*) rosin-barrel staves, (*d*) shingles, (*e*) box boards and cleats, (*f*) short stove wood, (*g*) molding strips and (*h*) ground chips for fuel. Moreover sawmills are built today for producing small wood specialties primarily from the log, the output of lumber in the form of boards or other building material being small and incidental. One large plant for instance has recently been built for making oval wood dishes, butter boats and clothes pins. A small sawmill followed by such a remanufacturing plant is usually motor-driven, while the sawmill alone might not justify the investment; for the small specialty machines can be driven electrically with convenience and economy.

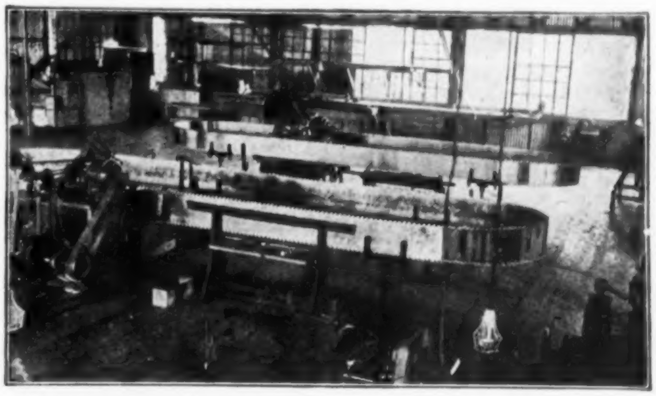


Fig. 1 Filing Room, with Motor Direct-Connected to Automatic Band Sharpener

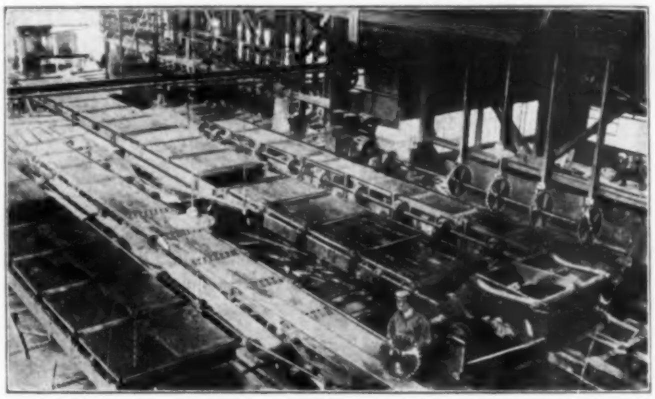


Fig. 2 Interior of Sawmill Showing Motor-Driven Slab Slasher and Trimmer

A unique condition of sawmill operation is that fuel costs nothing. The waste wood from the mill contains 8500 to 9150 B.t.u. per lb. when dry, the larger values coming from highly resinous wood, although as it falls from the saw it contains from 40 per cent to 50 per cent of moisture, or even more. Generally the mill

[1] Allis-Chalmers Manufacturing Company.

produces more waste wood than can be used for fuel or otherwise, and this surplus must be sent out in a long conveyor trough and burned in a pit or in a closed iron "burner." Decreased fuel consumption by saving power-transmission losses is therefore of no interest to the lumberman. The argument has even been made that decreased fuel consumption under the boilers is poor economy, because the saved wood must be conveyed a longer distance to the "burner" than to the boiler room, thus using more engine power.

In sawmills, as in other industries, motors give the advantage of unit driving, and the whole mill is not dependent on one line shaft or main belt. But it is to be noted that in the sawmill proper this advantage is not so great as in most other manufacturing plants. In a machine shop or other factory where one machine or small group of machines is making a finished product independently of all others, a stoppage of one machine or group will not affect the others. In a single band mill every piece of lumber from the log passes through all the machines serially, and a stoppage of one machine in the chain will soon shut down the mill. In a sawmill with two log-cutting saws there will be two streams of lumber, and failure of one machine will generally only affect one side. After the lumber passes the trimmer and reaches remanufacturing and by-product machines, the full advantage of unit driving is gained, for here one machine does not depend on another. With the foregoing conditions in mind, a comparison may be made, first as to plant details and cost, and second as to operating expense.

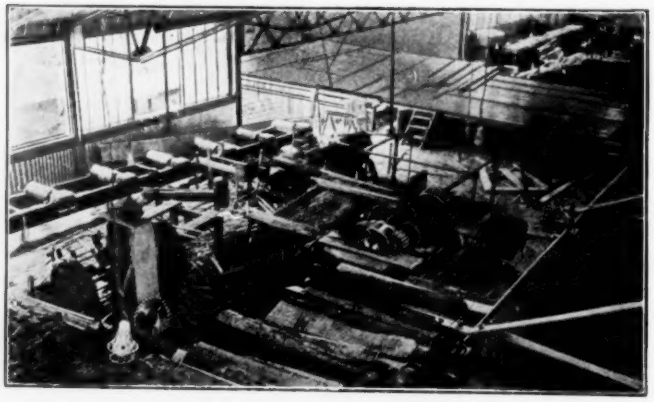


Fig. 3 Lath Mill Showing Direct-Connected Motor Driving Lath Bolter and Lath Machine

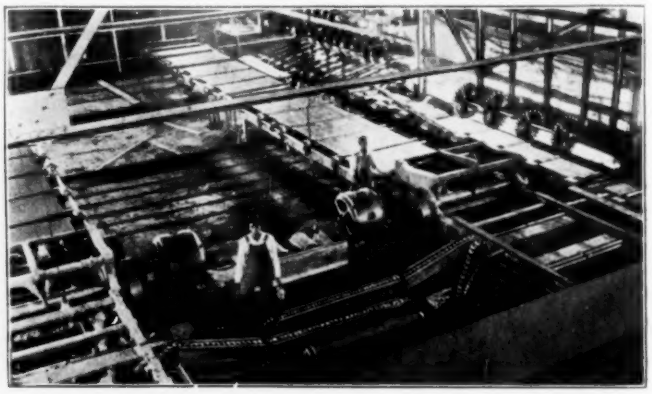


Fig. 4 Interior of Sawmill Showing Two Direct-Connected Motor-Driven Edgers

Comparison of Plant Details and Cost

Sawmill boilers are either ordinary horizontal tubular or of water-tube types. When burning sawdust a large furnace is required, which is generally of Dutch-oven design. A fuel-storage house is built close to the boilers, with the fuel conveyors arranged either to discharge sawdust from the mill direct to the furnaces or to carry it on to the storage house and return it when needed. When the belted mill and non-condensing Corliss engine are replaced by the condensing steam turbine and motor-driven mill the steam consumption of the prime movers will be cut about one-half, which allows a reduction of boiler capacity to be considered in comparing the cost of the entire plant. The boiler capacity needed for various auxiliary steam cylinders used in the mill will of course remain the same as before.

The belted sawmill, except in plants too small to be of practical interest, is generally driven by a simple non-condensing Corliss engine. It has not been found worth while to install compound or condensing engines when fuel was valueless, simply for the reduction in boiler plant. When motor driving of a proposed plant is in contemplation, the prime mover may be a simple or compound, condensing or non-condensing steam engine direct-connected to the generator, or else a steam turbo-generator. Fuel cost of course makes the gas or oil engine out of the question and plant cost eliminates hydroelectric power except in rare cases.

It has been said in an earlier paragraph that the standard sawmill plant includes a planing mill. This should be placed 200 ft. or more from the nearest roofed point of the sawmill proper (to meet insurance rules), which means 300 to 600 ft. from the main power house. Motor driving of new planing mills, except when very small, has become almost universal, so that this is generally assumed at the start. If we belt-drive the sawmill we must then have one prime mover for it and a steam-electric plant for the planing mill. It is obvious that there should be only one boiler plant and one engine room, containing both prime movers. But if the sawmill as well as planing mill is electrically driven, the two prime movers may be combined into one large enough to drive both mills, which is economical in first cost and is often done.

For the same reasons which have brought it into favor in other industries, the condensing steam turbo-generator has become almost universal in motor-driven sawmills; and compound condensing engines are not now running in any mill with which the writer is acquainted. When deciding on the method of power transmission, the choice for large mills is commonly made between (*a*) a sawmill belted from a simple Corliss engine and a planing mill motor-driven by a steam turbo-generator; and (*b*) both mills motor-driven by a turbo-generator. The comparison of costs which follows is on this basis for the larger mill, though for the smaller one both mills are belted from engines.

In a shaft-driven mill the weight and cost of the lineshaft and various countershafts are considerable. The power-receiving section of the lineshaft is about four inches in diameter in a single band mill, and 8 in. to 10 in. in diameter in the largest mills, and the shaft may be 300 ft. long. In large mills countershafts will be required for the log jack, log cut-off saw, log canter, band mill, gang mill, resaws, edgers (this requires a right-angle drive, usually through mortise gears), slasher, trimmer, hog, lumber sorter, timber trim saw, and lath mill. When the individual motor drive is installed all these shafts with their attachments are not required, and the difference in the total of sawmill machinery is almost entirely in these omissions. All the cutting machines, conveyors, and transfer and roll drives will be little changed. The amount of this saving is given below in three cases, the figures covering all sawmill machinery proper, installed, but no power-house equipment.

	Mechanical Drive		Electrical Drive	
	Weight, Lb.	Price	Weight, Lb.	Price
Mill No. 1.......	445,296	$112,345	402,749	$104,410
Mill No. 2.......	701,500	173,5 0	620,000	153,698
Mill No. 3.......	763,150	189,079	674,150	166,789

Sawmill and woodworking machines are almost always driven at constant speed, in one direction, and (except band mills, band resaws, and a few other cases) can be started at light load; so the squirrel-cage induction motor is generally applicable. The direct-current open motor is of course objectionable on account of fire risk from sparking commutators. For driving band mills, heavy band resaws, and in other places where large starting torque is necessary, the wound-rotor motor with starting resistance is used. The current (60-cycle, 3-phase) is commonly generated and used at either 480 or 600 volts, avoiding the use of transformers except for lighting. As all the motors will be probably set within 600 to 800 ft. of the power plant, the saving in wiring does not justify high generator voltage and transformers.

In the complete paper two tables are given showing the comparative cost of sawmills complete for both motor drive and shaft drive. In Table 1, which gives the estimated cost of a single band mill with a daily capacity of 30,000 ft., the figures are about 11 per cent higher for motor drive, but in Table 2, which is for a double band and resaw mill with a daily capacity of 120,000 ft., the first cost is about 8 per cent less for the motor drive.

Comparison of Operating Conditions and Expense

In operating expense the motor-driven sawmill makes a saving in power-transmission loss, upkeep of shafting and belting, use of oil, waste, and supplies, depreciation, fire risk and insurance premium. The complete paper gives a table showing the power consumption of various sawmills for both mechanical drive and electrical drive, the horsepower consumed being less in the case of electric drive.

The average life of belts in a sawmill is not more than four years, which means a running expense of 25 per cent of the total belting cost yearly. The saving in oil, waste, etc., by changing over from shaft drive to motor drive has been estimated at 40 cents per 1000 ft. of lumber per day. No attempt is made to give comparative figures for depreciation, but the lumber manufacturer's accountant should consider the low second-hand value of shafting equipment if it must be moved and refitted for new conditions, as contrasted with the easy interchangeability of motors. One of the lumbermen's mutual insurance associations recognizes motor driving by a reduction of 25 cents in premium. Another association, while not specifically recognizing electric driving, usually makes a 5 per cent deduction from total premium on account of the clear and open condition of the lower floor thus produced.

Separate steam engines are also sometimes used in a belt-driven plant to drive certain large machines (e.g., a gang mill) or groups of machines. These engines proportioned for their average load do not have the peak-carrying capacity of equivalent motors with a large generator behind them. When the mill is driven by several steam engines of small size a reduction of shafting equipment may be made, but each engine must carry its peak load without help. Motors of corresponding horsepower rating connected to one large generator will draw on an ample power reserve during peak loads. Two gang mills have come under the writer's observation, of the same size and make, one driven by a steam engine belted to it individually, the other motor-driven, both machines nominally running at 225 r.p.m. The engine-driven gang ran at 225 r.p.m. light, and 200 r.p.m. fully loaded. The motor-driven gang ran at 225 r.p.m. light, and about 223 r.p.m. loaded. As the rate of lumber feed to the gang is governed by the speed, the steam-driven gang was cutting about 10 per cent less than the other. Cases are on record where mills by simply changing from shaft drive to electric drive have increased their production 15 per cent. This problem of speed maintenance has not been sufficiently studied by sawmill operators.

Details of Motor Application

The equipment for hauling logs into the sawmill and cross-cutting them may be motor-driven. The remaining log-handling equipment is actuated by direct-connected steam cylinders. Sometimes an overhead log "canter" is used for turning logs, supplementary to the "nigger." It turns the logs by a hook attached to a chain wound on a drum and may be motor-driven.

On the other hand jump saws for cross-cutting boards and timbers, hinged transfer skids, the mechanism for raising press rolls on edgers and gangs, and for raising saws on a trimmer, are moved by direct steam or compressed-air cylinders. Also the carriage which holds the log while being sawed is almost always reciprocated by a steam engine through a wire rope or by a steam cylinder directly connected to the carriage itself. All these steam-actuated devices are so simple and positive in action that there is no apparent advantage in developing electrical methods as a substitute.

The other principal machines are connected to the motors through flexible couplings, except band mills, band resaws, and gangs. The band mills may be so driven, but there are certain objections which should be considered: the motor cuts partly through the mill floor, is inconvenient for inspection, and in the way of workmen; and motor speeds do not always match the speeds of the band mills, requiring a speed-changing device coupled between motor and band-mill arbor. Log band-saw mills are built with wheels 6, 7, 8, 9, 10, and 11 ft. in diameter. Irrespective of wheel diameter, the saws, and hence the wheel rims, are run at speeds up to 10,500 ft. per min.—plain cast-iron wheels at twice the ordinary limiting speed of engine flywheel pulleys. Another condition sometimes weighing against connecting a constant-speed motor directly to a band-wheel arbor, is that in northern hardwood mills the saws may be run at different speeds in winter and in summer. If much frozen timber reaches the saw, operators prefer to reduce the speed 1000 or even 2000 ft. per min. below that used when logs are clear of ice.

Gang mills run at such a low speed and require so much power that direct-connected motors of sufficient size would be very expensive, and standard practice up to the present has been to belt from a higher-speed motor.

The lumber-transporting equipment, including live rolls, chain transfers, chain and belt conveyors, is most conveniently and cheaply group-driven, though there is now a tendency to go farther in the use of individual small motors than there was a few years ago.

The filing-room machines for sharpening saws require little power and are arranged for mounting individual motors directly on the frame in most cases.

When specifying sizes for sawmill motors it must be remembered that very great and sudden peak loads are encountered, and the ratings must be larger on this account. In general, it is found that the load factor on an entire sawmill is about 60 per cent of the total nameplate rating of the motors.

A condensed list of the machines found in the ordinary sawmill follows, the sizes of motors suitable therefore being stated in each case.

Machines	Motor Sizes
Log jack, for hauling logs into the sawmill	25 to 50 hp.
Circular log cut-off saw, for dividing long logs after being drawn into the mill	25 to 50 hp.
Drag saw, for cutting off logs too large for the circular saw above mentioned	15 to 40 hp.
Overhead log canter, for turning large logs lying on the log storage deck or on the carriage	10 to 20 hp.
Band mill, for ripping the logs which are moved back and forth in front of it on the carriage	100 to 300 hp.
Circular head saw, sometimes used instead of band mill	100 to 400 hp.
Power setting machine, for moving log forward after every cut into position for the next cut. This machine is mounted on the carriage. Two types are used, one direct steam-driven, the other power-driven. The latter is used exclusively for the heaviest work, and motor may be mounted on carriage	5 to 10 hp.
Live rolls, or power-driven rolls, for transporting lumber after being sawed. These are connected and driven together in trains of 6 to 20 or more, according to the mill design; power required per roll	0.4 to 0.6 hp.
Band resaw, for further reduction of large pieces dropped by the head band mill. It may be either vertical or horizontal The latter is used for resawing slabs as well as splitting thick stock from the head band	75 to 200 hp.
Transfer chain tables, for moving lumber sidewise between machines. These are of such varying length and width according to the individual case, that no power requirement can be specified.	
Gang mill, for sawing entire log into boards at one passage through the machine. Two opposite slabs are taken off the log by the head band saw, giving the log two flat faces, after which it is fed to the gang	50 to 400 hp.
Edger, for ripping bark edges from the boards and squaring them	15 to 250 hp.
Slab slasher, for dividing waste stock into short lengths for lath, stovewood, or other by-products	20 to 75 hp.
Trimmer, for cutting ends off boards and making them of standard length	20 to 75 hp.
Swing cut-off saw, for hand-trimming of large timbers, etc.	10 to 25 hp.
Timber sizer, for surfacing two or four sides of timbers at one operation	50 to 60 hp.
Lath bolter, for preparing lath bolts from slabs or other waste wood	30 to 60 hp.
Lath machine, for making lath from bolts	20 to 30 hp.
Hog, a grinder with knives on a revolving disk, for chipping waste wood for fuel or other purposes	25 to 150 hp.
Planers, of great variety in size and type. The largest standard size requires about 75 hp.	
Exhaust fans, for transporting dust and shavings from planers to fuel-storage house	25 to 150 hp.
Chain conveyors, for transporting waste wood and sawdust, the length varying with the mill design up to about 350 ft	5 to 30 hp.

PROCESSES AND EQUIPMENT USED IN WOOD PRESERVATION

By E. S. PARK,[1] PITTSBURGH, PA., and J. M. WEBER,[1] ORRVILLE, OHIO

PROCESSES for the use of a preservative agent in the treatment of timber to prevent its decay or its destruction through the boring of insects may be classified into three groups: (1) Surface application: coating the timber with preservative by means of brush or spray; (2) open-tank treatment: immersion of the timber in preservative in open tanks; and (3) pressure treatments: immersion of the timber in closed tanks or cylinders with the application of pressure above atmospheric to force the preservative into the wood. It is only in the treatment of timber under pressure in a closed cylinder that the methods employed are interesting from an engineering standpoint, and this paper is accordingly devoted solely to such plants.

The pressure process has as its prime object, first, the distribution of the preservative throughout the wood as uniformly as possible; and second, the securing of an absorption of a sufficient quantity of the preservative to insure the results desired. The essential feature of all pressure methods is the use of pressure to force the preservative into the wood. This is accomplished in several ways, the kind of wood, the use for which it is intended or the kind of preservative used, making it necessary or advantageous to vary the methods employed. The timber is treated in closed retorts or treating cylinders built to withstand a pressure of 250 lb. per sq. in. and equipped with steam coils for heating the preservative.

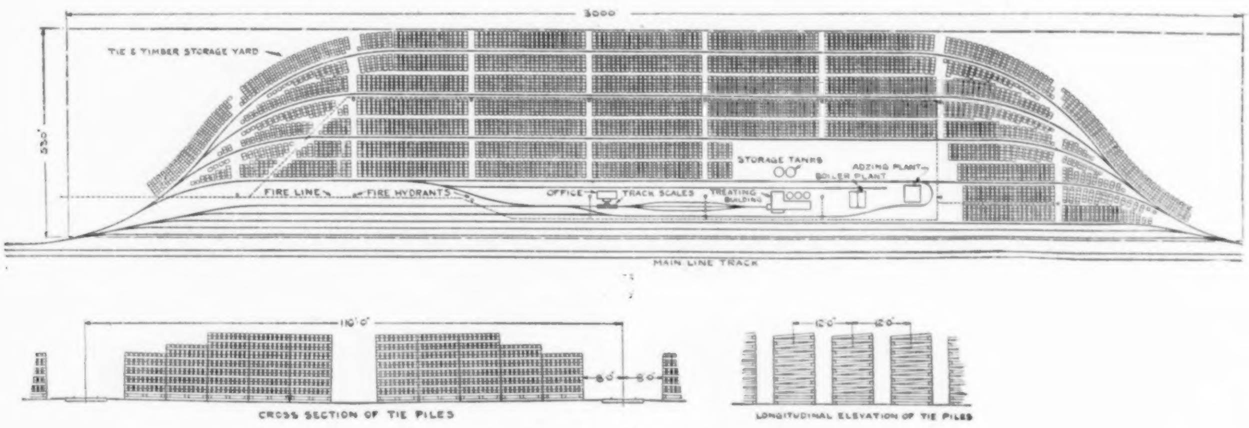


FIG. 1 PLAN SHOWING LAYOUT OF ENTIRE PLANT

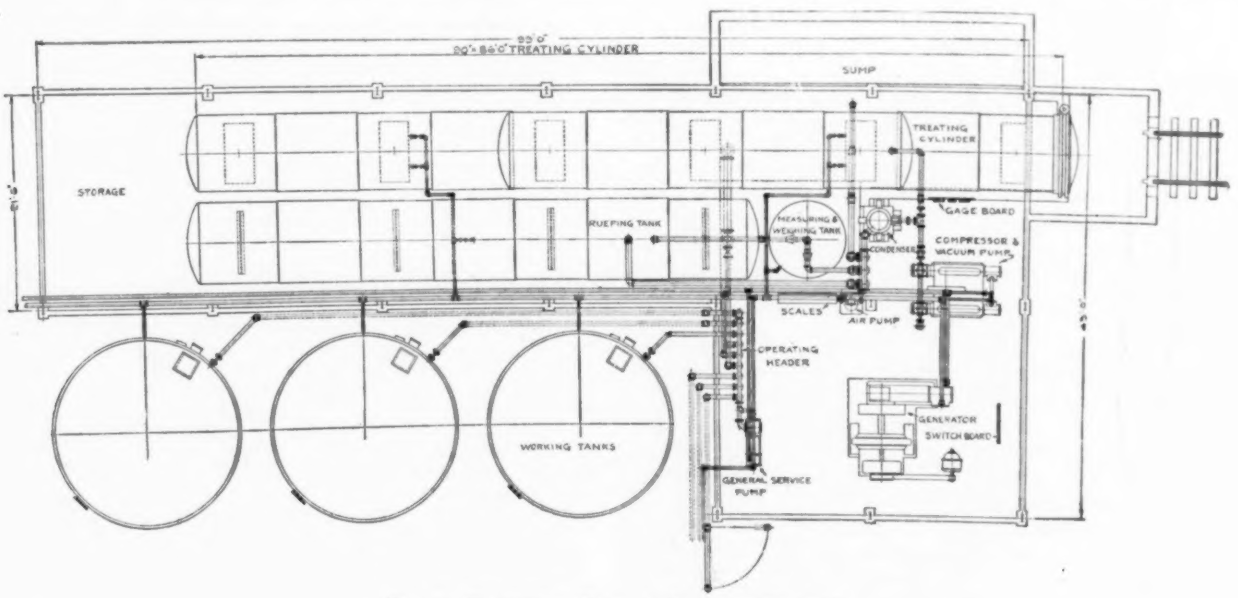


FIG. 2 EQUIPMENT USED IN TREATING PROCESS

The most widely used preservatives and those generally recognized as the most efficient are coal-tar creosote and zinc chloride, the latter being applied in the form of a 2 to 4 per cent aqueous solution. In one process employed in the treatment of cross-ties a mixture of 80 per cent zinc chloride solution and 20 per cent creosote is used. In treating with creosote the amount injected ranges from 4 to 20 lb. per cu. ft., depending on the kind of timber, the process employed, and the proposed use of the treated timber. When zinc chloride is used the aim is to treat the wood to refusal, the strength of the solution being regulated to give an absorption of approximately $^1/_2$ lb. of dry salt per cu. ft. of the wood treated.

PRESSURE TREATMENTS

Pressure treatments may be grouped into two classes as follows: (1) Full-cell process, the object of which is to fill the intercellular spaces of the wood as completely as possible with preservative; and (2) empty-cell process, the object of which is to secure as thorough and deep a penetration as possible with the use of a minimum quantity of preservative.

In the full-cell process the timber is placed in the retort, a vacuum is drawn, and, without breaking the vacuum, the retort is completely filled with the preservative fluid. The vacuum not only accelerates the entrance of the preservative into the retort but also makes it possible to force the preservative into the timber more quickly and with less pressure than is the case when the preservative must displace or compress the air in the wood. After the

[1] Pittsburgh Wood Preserving Company.

retort is filled additional preservative is forced into the cylinder by means of pressure pumps, the pressure being gradually raised to and maintained at 125 to 180 lb. per sq. in. until the required amount of preservative has been forced into the wood. The pressure is then released, the preservative drawn from the cylinder, and as a rule, another vacuum is drawn, the object of this final vacuum being to remove the surplus preservative from the surface of the timbers and hasten the dripping of the preservative so that the timber can be removed from the cylinder as soon as possible.

In the empty-cell process no preliminary vacuum is employed and to enter the wood the preservative must therefore displace and, to some extent, compress the air in the wood. Such is the treatment known as the Lowry process. In the more widely used Rueping process the entrance of the preservative into the wood is further retarded by subjecting the timber to an initial air pressure of from 50 to 75 lb. per sq. in., after which the preservative is forced into the cylinder at a higher pressure. After the treating cylinder is filled the procedure in empty-cell processes is practically the same as in full-cell treatments except that the final vacuum is held longer. The results obtained, however, are quite different, as in the empty-cell treatments the release of the pressure and the removal of the preservative from the retort permits the expansion of the air compressed in the wood. The effect of the final vacuum is to cause further expansion and, to some extent, expulsion of the air in the wood and a corresponding expulsion of a portion of the preservative that was forced in during the pressure treatment. The result is a thorough penetration with a minimum amount of preservative. Empty-cell methods are used almost entirely with creosote and in treating timbers which do not require the complete filling of the interstices of the wood. The cost of such a treatment is considerably less than by full-cell processes, as from 25 to 40 per cent less preservative is required.

In some cases, particularly where the preservative used is a solution of zinc chloride, or a mixture of zinc chloride and creosote, and in the treatment of green or partially seasoned timbers with creosote, the timber is first subjected to treatment with live steam in the closed retort, followed by a drawing of the vacuum to remove the steam and vapors. This, to some extent, vaporizes the sap and moisture in the wood and facilitates the entrance of the preservative.

Typical Treating Plant

It will be seen that the essential equipment of a timber-treating plant includes a treating cylinder or retort and facilities for carrying on therein; the application of live steam to the timber, the compression of the air, the application of pressure to the preservative fluid and the drawing of a vacuum, or, more strictly, a partial vacuum. A typical treating plant is shown in Fig. 1. It is a single-cylinder plant with a treating capacity of from 400,000 to 700,000 cross-ties per year, depending on the kind of wood treated and the particular method used. The plant occupies 36 acres of land and is connected at both ends with the railroad on which it is located. Connections with city water mains provide water for plant operation and fire protection.

The storage yard in which timber is seasoned before treatment and which occupies most of the premises has a capacity of 600,000 cross-ties. As the average seasoning period is less than one year the storage facilities make possible the seasoning of sufficient timber to operate the treating plant to maximum capacity. The yard is graded to give thorough drainage and is covered with 6 in. of granulated slag to prevent the growth of weeds.

Ties are unloaded direct from incoming railroad cars to storage piles. When ready for treatment they are loaded on to tram cars which are run into the treating cylinder. Switching cars about the plant and handling trams to and from the treating cylinder is done with a 22-ton fireless steam locomotive that is charged from time to time with steam from the main boiler plant. Its use entirely eliminates all locomotive fire hazard, which is an important advantage, especially if creosote is used as preservative. All tracks are standard gage (4 ft. $8^1/_2$ in.). The use of standard-gage tracks throughout the plant not only simplifies its operation and makes possible the use of larger cylinders, thereby increasing the capacity of the plant, but it also reduces the investment in tracks and the cost of their maintenance.

The track scales located in front of the cylinder building make it possible to weigh all material before and after treatment. This gives an accurate and positive record of the amount of preservative retained in the treated timber and furnishes a check on similar determinations made during the process of treatment. Track-scale readings cannot be used, however, when treating green or partially seasoned timber on account of the loss of sap and water during treatment.

The tank equipment of the plant illustrated consists of two tanks for the storage of the preservative and smaller working tanks for the mixing, measuring and handling of the preservative during the treating operations. The storage tanks have a combined capacity of 200,000 gal. or sufficient to operate the plant for 45 days when treating with creosote at the maximum rate. In treating with zinc chloride less storage capacity is required as the preservative is received and stored in concentrated form, either as a dry salt or a 50 per cent solution. All tanks are of steel and are equipped with heating coils arranged to use either exhaust or live steam. Such heating facilities are necessary in the working tanks as the preservative, when used, must be at a temperature of from 130 to 200 deg. fahr. In the storage tanks less use is made of heat but it must be available because of the congealing of creosote at low temperatures. The working tanks used to prepare the zinc chloride treating solution are further equipped with steam jets through which live steam can be injected and the solution thereby thoroughly agitated and mixed and at the same time more quickly heated.

Cylinder Building

The cylinder building houses the equipment used in the treating process proper and is shown in plan in Fig. 2. The treating cylinder is $7^1/_2$ ft. in diameter and 86 ft. in length and is built to withstand a pressure of 250 lb. per sq. in. Its capacity is ten tram cars loaded with cross-ties or a total of from 450 to 640 ties per charge, depending on the size of the ties and whether they are hewn or sawn. The treating cylinder is open at one end only and is equipped with a heavy door made by riveting a dished-steel plate on to a cast-steel rim. The door swings on hinges and is equipped with heavy tee bolts which are fastened to and swing from the end of the cylinder and which drop into slotted holes in the rim of the door.

After completion of the treatment the ties are moved on the tram cars to a loading track where they are loaded into gondola cars with a locomotive crane. The crane is equipped with a large grapple which engages and lifts a tram load of ties at one time. At some treating plants the same operation is performed by a gantry crane and at some of the older plants the ties are loaded from trams into cars by hand.

MACHINING RAILROAD CROSS-TIES

By D. W. Edwards,[1] Washington, D. C.

The cost of railway-track maintenance has vastly increased in recent years and one of the largest single items of expense involved in this work is the cost of cross-ties. Not only is their cost increasing with the diminishing supply of the most suitable timber and the growing scarcity of labor, but their life when unprotected grows shorter because of the greater destructive effects of heavier wheel loads and more frequent trains. Also the labor cost of renewing ties, exclusive of the value of the ties themselves, has advanced.

There are two causes of tie deterioration, decay and mechanical wear, and there is no economy in increasing the resistance to one without also increasing the resistance to the other. In some localities decay proceeds more rapidly than mechanical wear, and in arid sections ties wear out before they decay, but as an average the two destructive agents may be considered of practically equal importance.

It is evident that efficacy of treatment can be realized by doing all cutting before the treatment takes place so that the chemical may present an unbroken barrier to the attacks of decay spores.

[1] Greenlee Bros. & Co.

The majority of all ties are so winding or crooked that they should be adzed to secure proper bearings for the rails, but to do this after treatment is folly as it nullifies the effect of the treatment at the points where it is most needed, around the rail fastenings.

Trimming off the ends of ties by means of cut-off saws exposes internal decay which is not otherwise apparent because of the weather-hardening of the ends. A considerable percentage of ties are so decayed internally as to be of little value, and these may be thrown out before the cost of treatment has been expended upon them. This raises the average grade of the ties put in track and gives more uniform service. Trimming also increases the absorption of the chemical by the removal of the refractory case-hardened end surfaces.

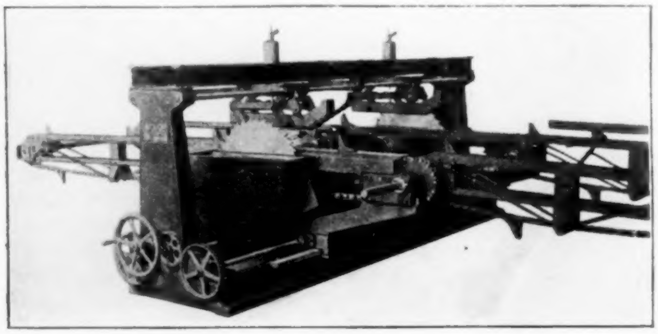


Fig. 1 Tie-Sawing or Trimming Machine

Briefly, ties are adzed to assure perfect rail-plate bearing; bored to permit chemical penetration, provide correct gage and perfect spike support; and trimmed for appearance and inspection. That the trimming operation is of the utmost importance and worthy of the most serious consideration cannot be too greatly emphasized.

Stationary Installations

For the complete four-unit type of trim saw, adzer, borer and brander, and with in and out tramcar tracks, skidways and conveyors, a building is required 66 ft. 6 in. long by 36 ft. 6 in. wide. The incoming tram track is 2 ft. higher than the outgoing one. This provides the desired elevation for unloading and reloading the trams in the mill and gives a down-grade pitch to the track for moving the empty tram cars around the mill by hand.

Trains of loaded tram cars en route to the treating cylinders are switched up the $1^1/_2$ per cent up-grade ingoing mill track. At the mill the track starts on a $1^1/_2$ per cent downward slope, passes through the mill on a return bend at the rear side and back to connect with the main line. Loaded trams are cut off the train and pushed on the down grade into the mill. When empty they are moved around the return bend to the delivery side.

Ties enter the mill in tram cars that stop in front of the skidways. A tram-car dumping rig removes the load of ties from the car and deposits it on the skidways. This consists of an overhead winch, driven by power, whose double capstans wind up chains securely anchored at their lower ends to heavy cast-iron abutments over which the ties are rolled by the tightening action of the chains. As the winch unwinds the chains lower and rest in slots in the floor, permitting the tram car to pass on.

The bales are removed from the tram cars just before the loads enter the front side of the mill. As the trams are unloaded they are moved around the circular track to the delivery end of the mill. Here they are reloaded and moved out to the front side of the mill where the bales are again applied.

The ties are halted in their fall down the skidways by railroad rails suspended from overhead. Two men, one either side of the skids, place the ties face downward in the correct endwise position on the machine's in-feed conveyors. The passage of the ties from this point through the machine is automatic and the trimming, adzing, boring and branding and delivery to the out-feed conveyors are accomplished mechanically. From the out-feed conveyors the ties drop into the outgoing tram car and are properly laid in place by two laborers. A loading form that outlines the bale circle assists the men in finishing off the load so the bales will fit in place when the loaded tram car leaves the mill.

Ties pass through the machines face downward and all operations are performed from below. Provision is made so the regular run of ties, large and small, straight and crooked, pass through as they may come and are automatically machined regardless of their irregularity of size and form.

Description of Machines

The double trim saw (Fig. 1) cuts about $^1/_2$ in. off each end of the ties. This removes the old hardened end wood, thus permitting better penetration of the chemical used for preservation, makes all ties of equal length, which makes for better and neater roadway, presents true surfaces for the brand, and principally discloses the condition of the internal state of preservation.

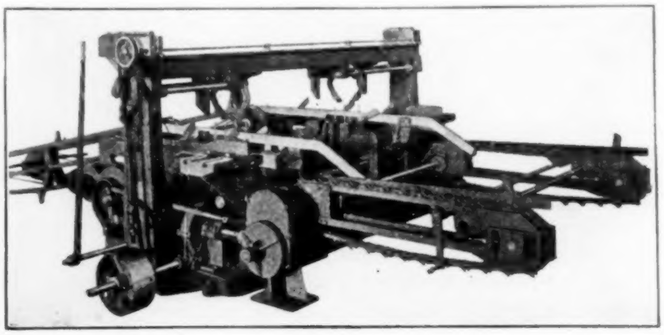


Fig. 2 Automatic Tie-Boring Machine

The design comprises a heavy cast-iron base upon which are mounted housings that carry the saw arbors and feeding mechanism. The housings are gibbed to the base and are movable longitudinally upon it by means of large screws and a back-geared hand wheel. Each carries an independently driven saw arbor. The feed consists of two endless chains driven through speed-reducing gearing from the main countershaft.

The tie-boring machine (Fig. 2) is usually employed in combination with the trim saw and adzer, but there are some cases, such as work on sawed ties, where boring alone may be deemed sufficient. The feed is by means of a set of hinged and counterweighted dogs which are reciprocated by a cam and lever movement through worm and spur gearing. On the backward stroke the dogs pass under the ties, rise behind them and carry them ahead on the forward stroke. This intermittent feed gives time for the boring operation to take place upon the tie which is between the clamps.

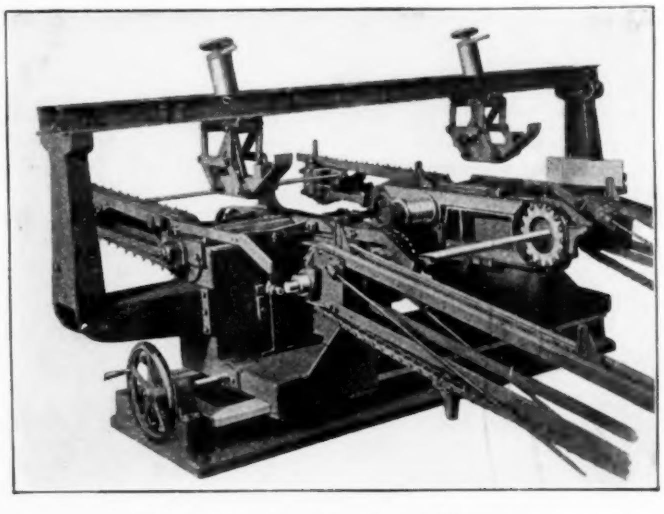


Fig. 3 Automatic Tie-Adzing Machine

A centering and clamping device holds the ties while the bits are boring, and automatically locates the holes so that the plate will rest correctly in the center of the available timber. This device consists of a pair of cam-operated spring-hinged centering and clamping jaws carried by the overhead supports and operated in unison with the bit-spindle feed. The centering jaws are assisted

in their clamping work by four sets of graduated hold-downs that prevent the tie from raising. Since the centering device operates on the exact center line of the rail, the boring is located in the center of the available timber.

The bit spindles are arranged in two groups of two, three or four spindles each with adjustment between the groups for gage, and between the spindles of each group for different widths of rail bases and tie-plate punching. A tie-boring templet having hardened bushings for guiding the tie-boring bits assures correct boring.

The automatic adzing machine (Fig. 3) produces perfect plane surfaces at the points where the rails or tie plates will rest. The heavy cast-iron bedplate carries two housings, one fixed and one adjustable thereon. Each of the housings carries an independent arbor with a shear-cutting, expansion adzing head 11 in. in diameter and cutting up to 14 in. wide. The feed is by endless chains fitted with carrying dogs and driven by gears from the main shaft. A self-adjusting equalizing device which automatically raises or lowers one or both of the ways upon which the ties travel over the cutting heads so functions that the depth of cut is divided equally between the two ends regardless of bends in the tie, instead of the low end being cut much deeper than the other.

In-feed conveyors deliver ties from the skidways to the machine proper. The trim saw is placed first in the train. Saws 30 in. to 36 in. in diameter are used. The adzing machine receives the ties from the trim saw. The boring-machine feed moves them at an accelerated speed to the bits. There they pause, are centered, clamped and bored, and passed on to the brander which is placed to the rear of the borer. Out-feed conveyors pick up the ties at this point and deliver them to trams. These conveyors are fitted with an accumulator which when thrown in causes ties to be retained by the conveyor while the outgoing trams are exchanged. This provides time for the operators to dispose of a loaded and place an empty tram in position without stopping the machine feed; thus constant production is maintained. A shavings-removal system is provided. The machines are built with shaving chutes at each adzing head and group of bits, with flanges for connecting the piping leading to a shaving-exhaust fan. A cyclone dust collector is used where shavings are delivered in the open.

Portable installation is advantageous when plant conditions make it more economical to take the machine to the ties than to bring the ties to the machine. Also where the machine may be required only a part of the year in one plant and can be conveniently moved to another and thus be kept in practically continuous operation throughout the year.

The car which forms the basis of the portable outfit must be of steel underframe construction, 50 ft. long and of the greatest possible width, within standard clearance limits. The power plant is usually a heavy tractor-type internal-combustion engine. When the trim saws are included in the equipment a six-cylinder engine developing 90 hp. is employed. When the saws are not included a four-cylinder engine of 62 hp. is sufficient. Through a suitable transmission with lever control the engine drives directly to the tie machines or to the car axles giving a self-moving speed of about 100 ft. per min. for traveling about the tie yard.

To operate a tie-machining plant a crew of eight men is required, consisting of one foreman mechanic, his assistant, the machine operator and five laborers. Six to seven ties per minute are run and 2500 to 3000 ties per day are machined, or about 500,000 per year.

Discussion at Forest Products Session

Edgar U. Kettle opened the discussion with references to Mr. Park's paper on Engineering in the Furniture Factories. He stated it was his belief that Mr. Park's provisions for the handling and transporting of material would be more applicable to the old-time system of laying out a plant and that if his scheme were followed the comparatively small manufacturer would be obliged to carry a rather heavy overhead. He also referred to the fire risks involved in such a system and gave as his opinion that it would be more advisable to install a modern kiln.

H. C. Dickinson spoke of the large economic loss due to fatalities among workers. He stated that while a few states have passed laws covering woodworking machines, there is no agreement among them at the present time. A code is now being prepared by the Workmen's Compensation Service Bureau, he stated, and an effort will be made to have it adopted by the various states that there may be some uniformity along these lines. Codes for the logging and sawmill industries can be obtained upon application to the Bureau of Standards, upon which the Bureau is very anxious to obtain criticism from practical men.

Marion Cattermole spoke of the possibilities of applying automatic machinery to the processes involved in furniture manufacture and thus reducing to a very large extent the cost of manufacture. Very little had been done in this direction, he said, and in his opinion the possibilities were enormous.

The chair next called upon Mr. C. P. Winslow, director of the Forest Products Laboratory at Madison, Wis., who spoke of the work of the Laboratory both as regarded its efforts along the lines of conservation of the natural resources and of its value to the industries. Referring particularly to the work the laboratory is doing to assist the industries in solving their problems, Mr. Winslow discussed the question of assigning values for stresses of the various woods in use. This question, he said, depends upon the size and character of the logs and until the consumer realizes this fact and will insist upon securing the material by grades, the problem of safe working stresses cannot be settled upon. He also spoke of the attention that is being given to the question of standardizing the improved grades of lumber and to the work done on structural columns. The boxing and crating for the shipping of goods for domestic and overseas shipment is another problem receiving the attention of the Laboratory, said Mr. Winslow, and this work has varied all the way from the packing of machine guns for shipment to China to the packing of glass and cream separators, and has involved the question of the kind of nail, the type of strapping, the selection of wood, and the thickness for different commodities. Due to faulty packing the losses from this cause amount to as much as $100,000,000 a year. He also mentioned the work of the Laboratory in connection with by-products, particularly their coöperation with the manufacturers of paper and pulp. One of the most important phases of their work, he said, deals with the utilization of small material and there was considerable work being done toward the development of glues which would give joints not only as strong as the wood itself but also as permanent. If this were done he believed it would have an important bearing upon the economics of the woodworking industry.

Herman M. von Schrenk spoke both of the extremely wasteful methods employed in the woodworking industry and of the great need for proper understanding and full application of engineering methods.

Mr. Hall's paper on Electrically Driven Sawmills, brought forth a number of questions dealing with the type and size of motors employed and the power requirements for the various machines in use with the many types of wood encountered. To these Mr. Hall replied that induction motors were almost universally employed and that for a saw not larger than 54 to 60 in., 3-hp. to 4-hp. motors would be necessary. This somewhat indefinite statement was commented upon by Benjamin F. Tillson, who requested that Mr. Hall supply, if possible, more accurate information as to the precise motor sizes which were required for actual operating conditions. Grant B. Shipley also discussed the question of motor sizes and ratings and moved that the question of electrically driven sawmills be referred to the Committee on Woodworking for further study and that they should collect data concerning power requirements of various machines for cutting the different types of wood, not only for large but also for small sawmills. This motion was duly seconded, put to vote, and carried unanimously.

In a written discussion submitted after the meeting, G. B. Muldaur called particular attention to Mr. Winslow's remarks relative to the work done at the Forest Products Laboratory on the strength of wooden columns and the lack of definite data on the subject. Mr. Muldaur wrote that the Underwriters' Laboratories of New York had recently completed a most elaborate set of tests on columns of all classes, including wood, and that the results of these tests were now being compiled in book form and would be ready for distribution in the near future.

Policies for Future Power Development

The Demand for Central-Station Electric Power and How That Demand May be Met Economically—Conservation of Natural Resources and Labor

By COL. JOHN PRICE JACKSON,[1] PHILADELPHIA, PA.

The primary purposes of this paper are (1) to present the problem created in this country by the present acute shortage of central-station electric power, and the large growth of demand for such power; and (2) to set forth the physical, public, and financial relationships that appear essential for relieving the present stress and meeting the continually enlarging demand with reasonable economy and conservation of natural resources and labor. The first purpose is dealt with in the first half of the paper, and includes a comparison with the situation in England. Treatment called for by the second purpose begins with the heading Natural Power Districts, and extends to the end of the paper. The latter is largely an exposition of the possibilities and advantages of unified power systems for supplying the power required by natural power districts.

IN a large industrial district with which the writer is familiar there is a large load ready and waiting to be connected with the central-station systems, and were there a wholly adequate and reliable supply of power at the disposal of the power companies in this territory, their present large aggregate load would be greatly increased. Expressed opinions of industrial and central-station men, as well as various statistics, justify the conclusion that an equally pressing situation exists in most or all of our important industrial centers.

The shortage of central power is serious by reason of the fact that it interferes materially with the natural productive growth of our country and with the prosperity of its several communities. Another even more serious element relating to such power shortage is the fact that it continues the use of a large number of isolated steam and electrical plants, most of which are consuming from two to four times the amount of fuel which would be required were the power supplied from efficient central stations. Moreover, the lack of sufficiently adequate central power systems makes impossible the economic utilization of many water powers which would become available if they could pump their power in the form of electrical energy into great electrical distribution systems having heavy demands.

To so develop the central power systems within a reasonably short time that they will meet the present deficiency, absorb the great amount of unconnected or isolated loads, care for the natural growth of demand, and utilize our fuels and water powers most advantageously, represents, in this country, a problem of gigantic dimensions which will require much wisdom to solve.

The English Situation

An even more striking situation affects England, where an acute shortage of fuel and inadequate development of electrical power had placed her, by 1917, in a position in which she was unable to keep up with the increased industrial growth demanded for war purposes. In this regard the situation was somewhat analogous to our own a year later, and is therefore of interest to us. The Board of Trade, a governmental body in England, appointed investigating committees of eminent engineers to study the situation and recommend programs for overcoming the difficulty.

As a result of these investigations it was found that enormous quantities of fuel were being ineffectively consumed by reason of the use of large numbers of comparatively small central stations, and by great numbers of isolated industrial plants.[2] The central stations also were unprepared to act in coöperation, and thus there were found in the area of greater London 70 concerns supplying electricity to the public with 70-odd generating stations, 50 types of systems, 10 different frequencies, and 24 different voltages.

As a result of these findings a bill was introduced in Parliament, which later became a law after modification of some of its compulsory elements. This law provides that there shall be a central body, known as the Electricity Commission, which is given wide powers relating to the national electric-power supply; that the British Isles shall be divided into large power districts in which electric-supply undertakings shall be "unified," the districting to be approved by further action of Parliament; that power boards composed of representatives of the power interests and others, shall be constituted in each of these regions; and these boards shall have charge of the operation of all power plants and transmission lines in their respective territories, including isolated plants, as well as the development and promotion of plans for expansions. It further provides for the transfer of central plants and transmission lines to the boards under certain conditions and gives them large powers of enforcement.

Direction of Development in America

Though the problem is much the same, the conditions in England differ in many ways from those in the United States, for here our commercial power companies have, of their own initiative, progressed far beyond those in England. In this country the growth of large, economical power systems is distinctly and actively under way with but relatively little direct governmental supervision. Furthermore, while English municipal ownership of power utilities has been actively growing, in America the commercial power systems have been developing with enormous rapidity. Again, during the ten years ending with 1917, America increased her central-station output from 123,000 to 241,000 kw-hr. per year per employee, with similar reductions in the use of fuel and other supplies per kw-hr., while in England the coördinate development has been relatively less satisfactory.

However, though the United States is in a better position than England, the demand here is insistent for even more adequate and reliable power systems, for the purposes of reducing at least the rate of increase of depletion of our natural resources, and for better conservation of our labor. To meet this very proper demand requires concerted action. Much has already been done in concert by way of coöperation and unification, but the time has come when more concrete and highly crystallized coöperative policies can be successfully determined upon by privately owned companies. Only by proper policies of this kind can such extensive governmental interference as has occurred in England be obviated.

As the United States is entering into the coming era of peace, indications are that it will face, in its foreign trade end and in its home market, a sharper competition than ever before from the other civilized nations of the world. Such competition is healthy and desirable, for it places us in a position where we must use every endeavor to produce along all lines with the greatest economy. This involves continued development of power production in the way which will most rapidly increase its efficiency in regard to the use of natural resources and labor, and at the same time provide, as far as feasible, a fully adequate and reliable power supply for all those in need of it, particularly for industrial purposes, wherever they may be located.

The Magnitude and Character of our Power Problem

The United States Geological Survey has recently tabulated the use of fuel for power purposes in the United States, based on estimates of 1919 power production and census figures.[1] It is estimated that 333,000,000 tons of coal were utilized in producing energy during 1919. Steam railways produced about 37.5 billion horsepower-hours and used 148 million tons of coal, or about 8 lb. per hp-hr. This includes the fuel for heating and auxiliaries. Manu-

[1] 1414 S. Penn Square., Mem.Am.Soc.M.E.

[2] Report of Electric Power Supply Committee (Cd. 9062), published in April 1919. (English.)

Abstract of a paper presented at the Power Section of the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

[1] Files of U. S. Geological Survey, Power Division, Sixth Ave., New York City (Henry Flood, Jr., Executive Secretary, under date of Nov. 1, 1920).

factories, not including mines and quarries, and not supplied by central stations, produced about 34.5 billion horsepower-hours by the use of 145 million tons of coal. This coal was utilized in numerous, mostly small, plants at a cost of about 8.4 lb. of coal per hp-hr. In obtaining this figure, fuel used for heating in the manufacturing plants was deducted, but water power was included in the total horsepower-hour output. The fuel rate for the output of the steam apparatus alone was estimated to be about 9.8 lb. of coal per hp-hr. In addition to the above, there was produced by central power stations and electric railways about 53 billion horsepower-hours using 40.5 million tons of coal at a cost of 1.5 lb. of fuel per hp-hr. With water power deducted, this rises to 2.3 lb. for the steam plants alone. With our modern plants this figure is of course much less.

The field for savings in fuel that could be made were the aggregate of the loads named above furnished from efficient central-station systems is evident from these figures. A large part of the unconnected load undoubtedly can and will be rapidly connected for central-station supply, connection of other blocks will probably be delayed for economic or other reasons, and part is probably not of a character for economical central supply. Loads of the character of the last two will therefore delay or prevent obtaining the full savings in fuel which would be possible were our total industrial load supplied from economical central-station systems, but nevertheless possible practical savings are very great. In addition to savings in fuel, very material savings in labor also can be made by the extended use of central power systems.

The equipment, as given by the same reference, required to produce the energies named heretofore, amounts to about 100 million horsepower, including steam-railway locomotion, of which nearly 20 million are installed in central electric power stations and electric railways, and an approximately equal amount in manufactories. Included in this grand total, about seven and three-quarters million horsepower are of water-power equipment. Something less than a third of the central-station equipment is hydraulic, or about five and three-quarters million horsepower. Economic considerations will largely determine the rapidity with which this latter figure can be increased by further development of the available unused water powers of the country.

Census figures show that from 1907 to 1917 the output of central stations grew from less than six billion kilowatt-hours to over 25 billion, or more than doubled each five years. It should be noted, however, that electric railways are not included in these as in the former figures. During the same period the value of the central power properties increased from approximately one to three billion dollars and the annual gross income from about 1.75 to 5.25 hundred million dollars.[1] That this growth has been continuing is borne out by an extensive investigation, made by the writer with Henry Flood, Jr., Frederick Darlington, and others, of a typical American power district where the central power business had just about doubled from 1915 to 1920. It was also found in the same district that there was every reason to predict another doubling of the business in the period from 1920 to 1925 and further substantial increases thereafter. Available information leads to the conclusion that conditions similar to those of this district prevail throughout much of this country.

The above figures referring to the enormous expected central power demand, and other considerations, indicate that the following are among the most important activities to be undertaken in connection with the power situation as it faces the country today:

(1) To so design the construction and direct the operation of central power systems as to make possible the highest practical economy and conservation of natural resources and labor; and also to provide a fully adequate supply of power for all purposes.

(2) To so arrange by interconnection of transmission systems and otherwise that the maximum amount of water power may be developed. The amount of water power utilized can and will greatly increase with the rapidly growing power demands, but in many important industrial sections of the country, where water power is scarce, it will require much wisdom to cause the increase to become a greater percentage of the total power than now exists. Many watersheds having reasonably constant flow, however, but not accessible for connection normally with central power systems, can possibly become of early value for developing the electrochemical processes of the country, and incidentally in reducing the consumption of fuel.

(3) To place steam plants, as far as possible, close to coal mines or on waterways in order that energy may be transmitted as much as possible in the form of electric power rather than in the form of coal, with resultant reductions of freight charges and relief to railroad traffic.

(4) To supply practically all industries with power from central power systems, which would result not only in an enormous coal saving, but also in a large saving in man power, maintenance supplies, and in transportation.

(5) To largely electrify the railways. This would make possible a great reduction in the fuel used for transportation purposes and relieve the railroads from carrying a large dead weight of coal freight for their own purposes, and also would make available the materially increased duty of railroad trackage and equipment which is possible by electrification.

(6) To not only make the central stations adequate for all of the above purposes and the expected future growth, but fully reliable.[1]

(7) To conserve a larger proportion of the valuable chemical constituents in the coal; such products are now recovered from only a small percentage of the total coal mined. Closely related with this problem is the conservation of our oil and natural-gas supplies. A discussion of these problems is not directly within the sphere of this paper, but it is believed that the suggestions for power development contained herein are along lines to coördinate with their solution. The problems are acute, for our oil and natural gas are showing signs of exhaustion, and though under present rates of consumption our coal may last a few thousand years, if the present increase in the rate of demand continues, it will be exhausted in a very limited time.

(8) To work out programs which will enable the financing of our power systems to be handled with facility. By the census there were three billion dollars invested in 1917 in the central-station industry, not including electric railways. About double that is needed now or as soon as the equipment can be produced, say, in 1922 or soon thereafter, and at least four times the 1917 capital will be required well before 1930 if reasonable progress is made.

The large sums of money indicated as necessary during the next few years for power development will in a large measure be spent even though no concerted effort be made to solve the power problem by a fully coördinated plan. But without concerted action there would be no possibility of such excellent returns, either in the form of earnings for the public and security holders, or in conservation of natural resources and labor. Were we advanced to a point of highly efficient central electrification of all power absorbers, with reasonable use of water power, the saving in fuel alone would amount to vast sums of money per year, with probable total savings of from two to three times as much if labor and all economies were included. The following suggestions with regard to power districts are intended to indicate the lines of a concerted policy of unification which would encourage these savings and at the same time accelerate central power development along the natural lines in which it is now advancing.

Natural Power Districts

The trend of power development during the past few years, and the present tendency, is toward the enlargement and unification of the power systems in large natural power districts. The boundaries of a natural power district are largely determined by the considerations that the region should be sufficiently large and the load of a character to enable it to sustain and properly use generating plants of a size and character necessary to give high economy, and at the same time have a territory sufficiently compact that the exchange of power between the several parts can be carried on conveniently and effectively. Due regard must of course be paid to the location and character of natural power resources. The actual area of a district to fulfil these conditions may vary

[1] United States Census, Central Electric and Power Stations, etc., 1917.

[1] J. W. Lieb set forth emphatically the need of "absolute continuity of service" in the discussion of Electric Supply at the meeting of the American Institute of Electrical Engineers in February, 1920.

widely; thus, the conditions of load, population, and natural resources demand a much larger territory for economical operation in California than is required by a district centering in New England.

A unified central power system supplying the power requirements of a natural power district inherently tends toward highly economical service, because such a system makes it possible to reduce to a minimum the aggregate amount of fuel used in the power plants through the possibility of raising the use of factors of the most economical plants of the region and lowering others, to take advantage of load diversities in the several parts of the district, to maintain a minimum of reserve equipment, to place necessary new plants at the points most effective from the standpoint of natural resources and the load, to more fully utilize water powers, and to permit a higher degree of reliability.

The selection of power sites for accessibility to coal mines, condensing water, water power, etc., has already become difficult with the present large stations and power demands, and with the great expected growth of these demands this problem will become more difficult. Unified action in a power district is of much value in this regard.

Those in charge of operations in a natural power district should design the unified system with the view to obtaining as far as practicable the same efficiency of production and delivery of power to all uses or users of power over the whole district, as is now attained in the big centers of power supply, if reasonably satisfactory conservation of our resources and the best welfare of our country and the power companies is to be obtained. It is evident that such objects require full standardization of voltages, frequencies, systems, etc., throughout the district, or better, throughout the whole country. Such standardization mostly exists in the United States, but it has not reached perfection.

At the present time the growth and unification of power districts is proceeding steadily, as may be noted by the situation in the New England States, the tying together of various companies and successful coöperation in western Pennsylvania and eastern Ohio, the getting together of a number of power companies in a group of the Southern States, in the unified control of the central-station systems of the Pacific Coast, etc. This kind of coöperative development was given a distinct and its most important impetus forward, during the war, by the Power Division of the War Industries Board, headed by Frederick Darlington, which was faced with the problem of relieving an acute shortage of both power and fuel, and the development of additional power to meet the rapidly growing demands caused by war activities. Mr. Darlington, after having examined the subject, concluded that the wisest procedure was to take advantage of and promote the natural tendency toward unification and coöperation of power interests in natural power districts, and with that object in view, dealt with several sections of the country as distinct units, or districts, including those referred to above.[1]

Experience during the war and various results found in peace times are sufficient to lead to the conclusion that both investment and operating costs will usually be so reduced by unification in properly limited districts as to make this kind of power supply attractive from the financial point of view.

Unified Power Systems

By the term "unified power system" (or unification) as used heretofore in discussing natural power districts, is meant a system in which the several component parts or companies combine and interconnect to obtain the efficiency and service which would be rendered if the entire district were operated by a single power company. Further, the terms used and discussions of the power problem herein are to be understood as confined to the generation and trunk transmission of power only, and not to include the distribution from the trunk-line load centers and its retail sale unless otherwise indicated.

The purpose and scope of this paper do not warrant entering into a discussion of technical engineering features, but the transmission of the power in quite large unified systems is feasible with existing equipment; thus, in a certain natural power district, a practical transmission system with switching and substations was recently laid out for a future growth to over a million and a half kilowatts. The technical work in laying out this system was largely done and was all approved by some of the best transmission engineers of the country. It is believed that projects which exceed this can be handled safely, though the difficulties to be met and the skill required for their solution should not be minimized.

The most simple method of handling a unified system, covering a natural power district, is by placing the entire generating and transmission apparatus in the hands of a single power company, either by purchase, lease, or the equivalent; where this is the condition no comment is necessary as to methods of operation or construction programs. Where it is not found advisable to arrange such a coalescing of the power companies the several systems of the several companies can be unified and operated as though they were under one ownership by the companies combining in the appointment of a power administrator, who is given full authority to direct the generation and delivery of power as he finds will result in the greatest economy to the entire district.

Where a power administrator is used, arrangements must also be made under which there will be an equitable distribution of earnings among the several companies. An example of a formal plan for accomplishing this is to have each integral company in the district compensated fully, with a reasonable profit, for its facilities in the way of power stations and trunk transmission lines with their substations, etc., which it holds ready for service. In other words, all company expense such as interest, depreciation, amortization, taxes, and insurance, with the addition of reserves and profits, constitutes readiness-to-serve expense for which the power companies are compensated. In addition to this, each company having generating stations or trunk transmission lines will be compensated in full for every operating expense incurred for power generated or transmitted under orders of the power administrator. The companies then pay for the power which they take from the unified system load centers, for retail distribution and sale, at rates per kilowatt-hour which, when applied to the aggregate power generated in the district, pay the combined ready-to-serve and operating charges named above. The price paid by a company for power purchased should, of course, have contained within it adjustments for load and power factors. The greatest difficulty entering into such a formal arrangement is the determination of the value of available facilities, but this need not prove an insurmountable obstacle.

A necessary corollary in this example is that the several integral companies in the district join together in laying out programs of construction in order that, as the load grows and additional stations and facilities are required, they may be developed in the way best to procure the highest economy for the district as a whole, and therefore, under the scheme dealt with, for each of the component parts.

In such programs of construction or in any arrangement of unification involving more than one company, it may readily be found advisable that the component companies join together in the development of a water power or the construction o' a large steam power plant, say, at a coal mine, through the medium of a new company, or otherwise, rather than by settling the entire burden upon one of the component companies. A successful case of such joint action is to be found in the modern steam plant at Windsor, W. Va., on the Ohio River, built jointly by the West Penn Power Co. and the American Gas & Electric Co. through the agency of a third company created and owned by them.

Rather than have a single ownership, it may be found more advantageous in a natural power district to form a company which would make the interconnections, handle the interchange of power and settle the intercompany bills, as is done in Switzerland or at Windsor, or to work out other arrangements to meet the special conditions and needs.

It should be noted that the two companies at Windsor operate largely in different states, while the several interconnected companies in the entire power district in which they are located cover parts of Pennsylvania, Ohio, and West Virginia. Little difficulty has been encountered by reason of the crossing of state lines.

The idea of unification with a central power dispatcher, acting jointly for several companies in a district, is not a new one among engineers; as early as 1911 William B. Jackson, as the result of

[1] Report on the Power Situation During the War made by General Charles Keller to the Secretary of War.

careful study of certain districts, recommended it and set forth in some detail the financial, operating, and installation advantages, and the possibility through it of reaching small communities not otherwise within the range of electrical supply.[1] Further, we have an example of a unified natural power district using a power administrator, which has proven satisfactory to the power companies within it and to its people. This is on the Pacific Coast, where the several companies have worked excellently in coöperation since 1918.[2]

For a recent period of power shortage accentuated by low water, unification arrangements were renewed by a written agreement among 17 power companies in Oregon and California, made last March before the State Railroad Commission, a part of which follows:

> We, the undersigned, hereby pledge that we will obey and carry into effect to the limit of our ability all rules, regulations, and orders of the Railroad Commission concerning diminution of service or taking on of new business, and interchange or delivery of power between the several companies.

The Railroad Commission was voluntarily selected by the companies as their agent and arranged to exercise the full powers, thus delegated, through a power administrator. There seems to have been no vital reason for having selected a public board as power administrator rather than any other person or body in whom the power companies and people have full confidence.

It is altogether to be expected that as unified systems in the natural power districts of the country develop, they also will find it advantageous to make interconnection for emergency and other services. In some cases it may be found that switching arrangements for connecting up the ordinary transmission lines in contiguous districts will be sufficient. In other cases it may be found that several unified districts can, to advantage, join together in the development of a large water power, say, such as on the St. Lawrence and Niagara Rivers in connection with the New England and Middle States, and part of Ohio, and perhaps in the building of a system of plants in the coal regions of Pennsylvania and West Virginia, for supplying more easterly territories.

W. S. Murray has suggested that some such arrangements may be desirable between the Atlantic Seaboard districts which he is at present investigating as the representative of the United States Geological Survey.[3] It should be added here that the investigation being carried out by Mr. Murray and his staff, as a bureau of the United States Geological Survey, is in response to a special act and appropriation of Congress. He has been given wide scope to study the present conditions of power utilization in a belt of territory bordering the northeast Atlantic Seaboard with its enormous industrial and railroad activities and to work out plans for electrical supply which appear advantageous. He has surrounded himself with a group of strong advisers whose joint judgment will be generally accepted. The findings will doubtless give another impetus to the use of central-station power and to unification.

Public Relationships

One of the most important elements which should be considered in bringing about the unification of a power district is that of proper relationship with the public. Effective joint publicity should be inaugurated which would make clear to the people of the district the value of unification, and the ways in which the public can serve to aid in bringing about such a condition of power supply.

The prosperity of every industrial community and of the nation is vitally dependent upon success in properly meeting the present and expected power demands of the country. There is every reason, therefore, to believe that redoubled attention, on the part of the power companies, to the subject of public relations—particularly if activities of this sort are under the direction of joint authorities for entire power districts—will create an adequate popular support for unification and other measures necessary to meet the situation.

Special attention should be given to the development of laws whereby capital invested in power systems would be reasonably assured by law as to stability and return, instead of being subject to a modified status with every change of administration or public-service commission. One of our most capable and experienced financiers and industrialists in emphasizing this, recently said that, "Public-utility commission actions should be governed by definite laws". . . . "They should be bound to respect and recompense capital invested in public utilities according to plans definitely set out by enacted laws, so that the security to investors in railroads, electric power properties, gas plants, etc., would not be dependent on the personal attitude or judgment of transient commissions." Another man, also of high national standing, makes the statement that: "This is a government of laws and not of men, but there seems an increasing disposition to establish commissions not guided by any fixed or determined principles of law, but which have wide powers and whose decisions are frequently governed by expediency or opinion."

Laws should be enacted which would be as liberal in the matter of rights of way for power plants, transmission lines, and other needs of the power companies, as is the case for railroads or in various states with regard to water-power plants. It is particularly desirable also that the law be so drawn as to enable the power interests to share economies brought about by the ingenuity, energy, and capacity of their personnel.

With regard to this latter item it is well to call attention to the classical example of the South Metropolitan Gas Company of London, which is acting under a sliding-scale law. As the law stood in 1899, when the selling price of gas was not above 3s. 6d. per 1000 cu. ft., the return on the capital invested in the gas companies might be 10 per cent. (These figures have been modified, but the method is still in force.)[1] When the gas companies were able to reduce the price of gas, through economical operation, by a penny a thousand cubic feet, the return on the capital invested might be increased by $^1/_4$ of 1 per cent; increase of interest on the capital investment continued with each penny lowering of price, while raising of the price lowered the permissible dividend. It may be of interest to note that the returns on the capital gained under this sytem are so distributed as to give an incentive to the management and employees to make economies. A somewhat similar scheme is used by the Boston Gas Company of this country. The arrangement has the advantage of rewarding good service and at the same time bringing financial profits to the community. In the case of light and power companies the application of these methods is more complicated by reason of the varying rates charged for electric power, but the obstacles are not insurmountable and the principle is well worth considering.

The people of each power district should be brought into a closer relationship with the power companies by the distribution of securities to a maximum number of holders. If arrangements are made for payment in small installments and the stability and returns of the securities of most of our power companies are made known, there should be no difficulty in obtaining their wide distribution. Indeed, it is doubtful if there are many building and loan or savings bank associations which can show such excellent returns with reasonable safety as can our best organized electric-light and power companies. This, and obtaining financial support from large consumers, may not secure a major part of the necessary capital, but it will bring excellent returns in the nature of public support.

Financial Considerations

In order to procure the large amount of money necessary for obtaining adequate and reliable power in the United States, it is essential not only that the best plan be adopted from the engineering and business standpoints, but that it shall be one which is acceptable to the public and to public-service commissions. The plan must be one which will gain the definite approval of the latter, and the securities offered by power companies in obtaining neces-

[1] Advantages of Unified Electric Systems Covering Large Territories, by William B. Jackson, Proc. A.I.E.E., vol. xxx, 1911, page 131.

[2] Reports of the Railroad Commission of California for July 1, 1917, to June 30, 1918, and for July 1, 1918, to June 30, 1920.

[3] Economical Supply of Electric Power, by W. S. Murray et al, Midwinter Convention of the A.I.E.E., February 1920.

[1] Report on Profit Sharing and Labour Co-Partnership in the United Kingdom, 1912. (English.)

sary funds should, as said, not only have the approval of the commissions, but be practically safeguarded as to earnings through stable action of the Government. The financial situation, under a properly designed unified plan for power districts with proper interdistrict connections, such as have been suggested, would better command the support of the public and protect their investments than would be the case were the necessary facilities installed and operated by several independent companies; in other words, there is undoubtedly better opportunity for such safety of investments and support by the public and the public-service commissions for a single well-worked-out plan covering a whole district, which would be clearly the right way of performing the work economically, than there would be for three or four different plans put on foot by several independent companies operating in one natural power district.

Since the success of the electrical power business in meeting industrial needs depends upon securing the necessary capital, this feature with regard to financing may easily be a controlling factor in the results. The power companies are practically obligated by their franchises and other contracts to supply the facilities needed to provide an economical and sufficient supply of electrical power. If they should not do this through failure to make the necessary financial arrangements, or for any other reason, the results which would naturally follow would be most unfortunate, and would probably lead to undesirable and in the end nationally injurious curtailment by the Government of the advantages of the strong personal initiative and incentive which now exist in the power industry of this country.

Discussion

Following the presentation of Colonel Jackson's paper at the Power Session of the Annual Meeting of The American Society of Mechanical Engineers, there was general discussion, the substance of which is presented below:

T. Kennard Thompson, who was the first to discuss Colonel Jackson's paper, stated that, as everyone knew, the greatest source of power in this country, and probably the most unified source of power in the world, was the Niagara River, and that by placing a dam four miles below the Falls nearly 200,000 hp. could be developed at a cost of not more than five dollars per horsepower. He exhibited some slides showing the site of this proposed dam and stated that power could be transmitted at 60,000 volts with a loss of only 10 per cent. According to W. S. Murray, he said, this voltage could be raised to 220,000 so as to transmit the power at least 500 miles, which would then take in both the Lake Superior and Quebec districts. It would thus reach 19 states of the Union and two provinces of Ontario, or 60 per cent of the entire population of the United States and 80 per cent of the entire population of Canada. Mr. Thompson also stated that it would be possible to develop other plants on the St. Lawrence and to obtain several millions of horsepower. If this were done, he said, Montreal would be one of the greatest seaports in the world.

E. H. De Lany suggested the founding of a Federal Bureau of Engineering and Research. "I think," he said, "that every technical bureau that has ever been inaugurated by the Federal Government has proved itself worthy, and has the support of the people." He urged the creation of the Federal Bureau on the grounds that no private corporation or society could afford to advance the funds necessary for experimental purposes and that such a Bureau could do a great deal more than either corporations or societies in the way of securing the legislation necessary to carry on its work.

John W. Lieb, in referring to Colonel Jackson's statements of the conditions in London where there are a number of plants with various frequencies and voltages, said that we face no such difficulties in this country because the systems in our great cities are fairly thoroughly consolidated. He called attention to the fact that the British Commission assumes control, not merely of "linking in," as the general term is there, but also assumes to say what type of installation an industry should use and also whether the industry ought to be allowed to instal such a plant or whether it should be made a part of a system which already exists. Furthermore, they assume the right to say what shall be the voltage and frequency in order that the proposed plant may form a part of the future prospective original system. Referring to capital expenditures and the availability of capital, Mr. Lieb said: "What the public wants is service, and the American public is willing to pay a reasonable and proper price for that service. But to obtain it, it must be possible to have adequate rates under proper supervision and regulation." Mr. Lieb also stressed the importance of the reliability of service, saying that it is absolutely essential in our great metropolitan centers to have absolutely reliable service, and that from an engineering standpoint a complete reliance on a transmission line alone, without an adequate steam stand-by, was not a safe and proper thing. The usual method of tying in and linking up of systems was also commented upon by Mr. Lieb. He urged the carrying of a joint reserve instead of each power company carrying its own reserve and meeting the capital charges thereon. "There is an important economic advantage," he said, "in having a joint reserve that is common to all." As to the tying in of systems, Mr. Lieb stated that what was necessary was not merely to have two original systems and then incorporate them by tying them together at the ends, but that the tie line should be of large capacity and should connect the systems at important generating points so that the load could be shifted back and forth at the points where it was needed. Mr. Lieb also referred to the work being done by the Superpower Survey and stated that if we wished as a nation to be leaders in industry we must go ahead with such comprehensive plans, which are essential to our economic national life.

Walter N. Polakov urged that the coal supply be conserved by utilizing distillation processes for the recovery of products now lost. We should put our coal, he said, through a low-temperature distillation process and thus obtain not only a smokeless, dustless, and odorless coal, but also certain gases valuable for domestic purposes and a residue valuable for fertilizers. Benzol, which can be used as a substitute for gasoline, as well as coal tar could also be obtained.

Harold L. Doolittle spoke of the systems now employed in California for the interchange of power. The scheme functions through the Railroad Commission and practically all of the companies in the state have agreed that future transmission lines shall be so constructed that ultimately a 220,000-volt bus line will run from one end of the state to the other and that in this way it will be possible to take advantage of any diversity in the load. Experiments have already been made on the line, he said, and there is no question as to the practicability of the scheme. In regard to economy of operation, he pointed out that there should be some method adopted which would reward public-service corporations for increased efficiency. To accomplish this in California, he said, the Southern California Edison Company had placed before the Railroad Commission the proposition of establishing some standard of operation, so that if any saving were made the corporation would be allowed to put that money in a fund. In other words, create a surplus, so that at the end of the year rebates could be made, 50 per cent to the consumer, 25 per cent to the stockholders in the company and 25 per cent to the employees. Mr. Doolittle stated that this proposition, however, had not as yet been acted upon.

W. S. Murray referred to the waste of power through the use of isolated plants and also by the railroads, and stated that the whole object and incentive of the Superpower Survey is to see that this may be corrected. Regarding the development of our waterpower, he said that the waterpower available in the superpower zone represents but a possible 15 per cent of the whole, and that therefore we must confine ourselves to a most careful consideration of the highest economic development of steam power. Mr. Murray also contributed a written discussion of Colonel Jackson's paper, extracts from which follow:

In connection with the railroads, the fuel consumption by steam engines against electric engines, respectively, in the passenger, freight, and switching service, has been shown to be 2, 2½, and 3 to 1, and this with a thermal efficiency of the central stations driving them not greater than 8 per cent. Today the efficiency can be made to be 18 per cent, and this means that those ratios will be in excess of 4, 5, and 6 to 1. The best steam freight locomotive when burning 5 tons throws 3 tons away.

Mr. Henry Flood, Engineer-Secretary for the Superpower Survey, has placed in my hands a collaborated statement which shows that had the

superpower system been in service as of 1920, there would have been saved 30,000,000 tons of coal per annum. In 1925, based upon the growth of power on a conservative basis, these savings grow to 33,000,000 tons of coal, and as of 1930 the conservation that can be effected is estimated at 59,000,000 tons per annum.

These preliminary estimates of the savings possible through the centralization of power supply do not consider the complete electrification of the railroads in the district, nor the complete electrification of industry; for instance, on the heavy-traction railroads it is estimated that 6000 miles can be economically justified for electrification in 1920 of the total 30,000 miles within the region, and it is further estimated that the increase in electrification would grow only at a rate of traffic growth for this region up to the 1930 period, so that it considers the electrification in total by 1930 of only about 20 per cent of the total track mileage. In industry these estimates consider taking over to central power-supply sources only 50 per cent of the total power in the manufacturing industry, so that it is reasonable to state that these estimates are conservative and that they do not carry out the electrification of industry to the point of saturation.

Colonel Jackson points out the difficult situation in England with its innumerable small stations and varying frequencies. It is a lesson to us what we should avoid. Our plants are larger; our main frequencies are but two, and yet it is amazing to know that the capacity of the average-size plant in the United States is not greater than 3400 kw., and its consumption of coal per kilowatt-hour is 3 lb. The superpower stations projected will be on the order of 300,000 kw.; their economy should touch 1.5 lb. of coal per kw-hr. Again, a load factor of 40 per cent carried by a central station requires that station to burn 85 per cent of its coal before its kilowatt capacity has been taxed 35 per cent, and the remaining 65 per cent of its kilowatt capacity is used while burning the remaining 15 per cent of the coal. I think this visualizes what I have just said regarding the employment of the present large stations, which, if they are not in a position to furnish large blocks of kilowatt-hours, stand ready, however, as peak-load plants to furnish the capacity with which a very small amount of energy (kw-hr.) is involved.

Colonel Jackson says, "The time has come when more concrete and highly crystallized coöperative policies can be successfully determined upon by privately owned companies." I am in perfect accord with this statement, and I wish to emphasize at this point that the Superpower System as proposed stands alien to none, helpful to all, and that its construction will not be upon a competitive basis. The entity and franchise rights of the present central stations must be respected. The Superpower System through delivery and exchange will place energy upon the distributing mains of the present public utilities, and there its functions cease. Its duty will be the generation of a maximum amount of power for a minimum consumption of coal. It is to be purely a power and transmission company and will have no relations with the customers of power, except that those customers be public utilities.

Through the uneconomical production of power, coal is in the yards, on the sidings, and on the main lines of the railroads. It is competing with the raw and finished commodities for cargo space. Think what a saving of 59,000,000 tons of coal per annum in 1930 within a district between Boston and Washington, inland 150 miles, means! If that amount of coal is not required to be mined, first we have conserved nature's storehouse; second, we have relieved the railroads of its transportation and created cargo space for our other high-priced commodities which industry and expansion demand; and third, through the new process of power production as recommended in the Superpower System we will put a very large percentage of the remaining coal required for power and lighting in the form of electricity and thus create an overhead carrier system and automatically release cargo space for other important commodities.

Colonel Jackson's summation in the paragraphs of his paper numbered (1) to (8) is splendid, and the integration of these indeed furnishes an epitome of the specifications of the work undertaken by the Superpower Survey, viz.:

(*a*) Allocation of wastes and their amount, due to the present improper form of power production and distribution, and

(*b*) The recommendation of the regional plant through the means of which these wastes may be eliminated.

I am struck by his reference in Par. (7) to the average cost of a kilowatt installed by central stations up to 1917. This is $333, including the distribution system. In the past we have been required to build, due to the lack of interconnection, a plant and a quarter, the additional quarter being necessary for spare capacity. Through the proposed interconnection offered by the Superpower System, not only will this additional quarter capacity disappear, but through diversity the plant's capacity may be run below the 100 per cent line, and instead of our small plants (averaging but 3400 kw.) at a cost of possible $200 per kilowatt, the larger plants may be built at probably less than half that amount. Indeed, we have arrived at the period for the construction of enormous plants to carry the great base loads. The present unassociated load factor (and by unassociated is meant the independent operation of the industries and the railroads) now existing at 15 per cent will be lifted to 50, and thus it will not be difficult to visualize a 4,000,000,000-kw-hr. base load in a pool of power aggregating 36,000,000,000 kw-hr.

Colonel Jackson has said that special attention would be given to the development of laws whereby capital invested in power systems should be assured of a reasonable return, and in this statement he strikes a note of insistant requirement. Finance and engineering go together. It is indeed a case of E Pluribus Unum. Viewing the Superpower System from a commercial aspect and entirely apart from its basic and national importance, namely, the conservation of the millions of tons of coal previously referred to, the savings to be effected by it in money will represent $300,000,000 per annum, even at as early a period as 1925, which amount will steadily increase as years multiply the units of power required.

The functioning of the Superpower System is within the limits of power generation and transmission. It ends where distribution begins. If it can furnish a kilowatt-hour to a local company by the expenditure of two pounds of coal where the company has been burning three pounds, it is reasonable to expect that such a company would take the power so delivered to its distributing lines, particularly when it can obtain such power with a relatively small investment, smaller than it would have been in providing its own facilities to produce the power at such a low coal consumption. In fact, there are many distributing companies so located that it is absolutely impossible for them under any condition at the present time to reduce their coal consumption much below their present figure.

Wm. B. Jackson called attention to the fact that by the development of interconnections and of network transmission circuits it would be possible to utilize many water-power sites which might otherwise remain undeveloped. Furthermore, with a reliable transmission system it would be possible to reduce the investment in steam-power stations because of the fact that the maximum capacity of the water-power plant will always be available and consequently can always be operated at maximum capacity. Mr. Jackson also discussed other factors in the development of hydraulic stations, touching upon such points as more effectual operation of the existing steam plants, coal savings, load factors, and capacity of transmission lines.

Charles W. Thomas referred to the newly created Federal Power Commission and its duty of granting preliminary and permanent licenses for the exploration and final development of water powers. He said that in his opinion influence should be brought to bear upon the Commission so that permanent permits would not be issued to those who might finally develop important water-power sites in an incompetent way.

Henry Harrison Suplee, referring to flood control of great rivers, particularly the Mississippi, the Ohio and its tributaries, stated that it had been suggested that by controlling the run-off rainfall much nearer the source and by supplying proper catchment basins, power could be developed, while at the same time losses due to floods could be entirely avoided. Mr. Suplee also spoke of the difficulty of securing local interest in one part of the country for the benefit of another and suggested that it would probably require a Federal bureau with appropriations from Congress to develop such a scheme.

H. P. Quick contributed a written discussion in which he reviewed the method of financing hydroelectric enterprises that have been built in this country, Canada, Mexico, Brazil and Spain, by money furnished partly by bankers, partly by capitalists, and partly by small investors. The promoters of these enterprises secured their money, he said, by first getting a majority control of existing going enterprises and future consumers of their power, and then issuing bonds and selling stock in new development companies, or railway, light and power companies organized for the purpose of hydroelectric development and power distribution in the various municipalities. These bonds and stock were sold as the reconstruction or improvement of the going concerns or as the new construction demanded and the revenues increased with which to pay interest on the bonds. Of course the purchase of stock or the gift of stock having great prospective value increased the income of the concerns, and the ability, standing and character of the managing engineer-president-financier and his associates furnished the additional incentive to investors to open up.

As to the attitude of American bankers toward such enterprises Mr. Quick wrote as follows:

Did American bankers assist to any great extent in these developments of foreign enterprises? Not a bit of it, and perhaps they were wise in view of the revolutionary possibilities and actualities in some of these countries in recent years. But plenty of foreigners—Canadian, Englishmen, Frenchmen, Belgian bankers and others invested in them, as they saw a large profit and thought the countries stable and were accustomed to such investments.

Now, if those same developments had been undertaken by the foreigners' own nationals, how would the undertakings have been financed? Why, by their governments, by securing control of going enterprises, or by special taxation of utilities or communities to be benefited; and this revenue or taxation, or perhaps the revenue from imports and exports, or the income from foreign stocks and bonds as collateral, would be used or set aside periodically to pay the interest on new government bonds issued

(*Continued on page 110*)

Effect of Load Factor on Steam-Station Costs

By PETER JUNKERSFELD,[1] BOSTON, MASS.

The following paper discusses the factors affecting steam-station costs, particularly the load factor. Financial loss, the author states, will result whenever it becomes necessary to operate a power station at a substantially higher or at a substantially lower annual load factor than that for which the station was properly designed. The load factor should be carefully considered in locating a central station as well as in the selection of equipment. Fuel, usually an item of great expense, is dependent upon the load factor, the efficiency in the use of fuel being greater at the higher load factors. Curves are given to show relative generating costs and boiler rating as affected by load factor, typical week-day load curves and load factors, and the load factor as it occurs from day to day and month to month.

The annual load factor is an indication of the number of hours per year that the dollar of capital expenditure in a steam station can be kept at work. The expense of using this dollar is just as great when it is working 100 hr. as when working the full 8760 hr. of the year. The returns are, however, in direct proportion to the number of hours per year that this dollar is kept at work, or in other words, to the annual load factor. For example,

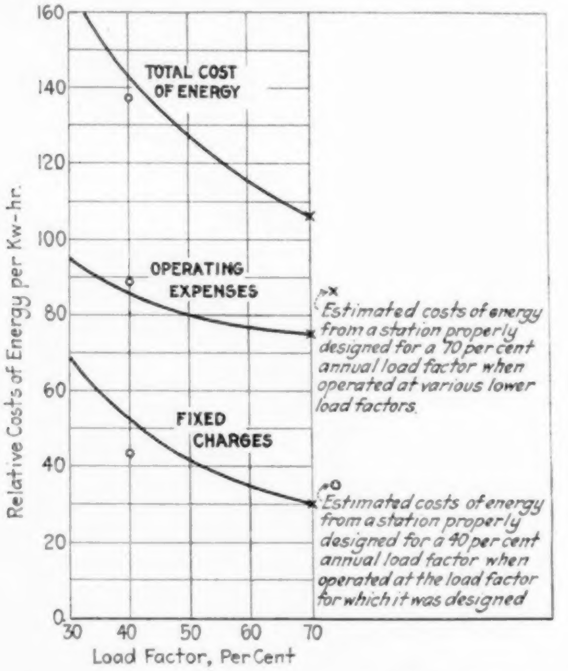


Fig. 1 Relative Generating Costs, Showing the Effect of Designing a Station for Too High a Load Factor

if the annual load factor of a power station is increased from 30 per cent to 60 per cent the fixed charges per kilowatt-hour are cut in half.

Load factor is the ratio of the average to the maximum output during any definite period of time. It is usually based upon an average demand for, say, 15 min., and upon output for a day, week, month, or year. It may apply to a system having many generating stations and serving many communities, or merely to one power station or even one unit in a power station.

The annual load factor of a central-station system nearly always changes very slowly. Special effort to secure a well-diversified business together with the new uses of electricity which are constantly arising contributes substantially to improvement in load factor.

The ordinary factory, working a 44-hr. week with the usual lay-offs for holidays, keeps a power station busy for only one-quarter of the 8760 hr. per year. Residence and street lighting tend to improve load factor in the summer, but are less and less of a help as the days grow shorter, until they finally change from a blessing to a burden upon the plant, during the months when the lighting peak overlaps the end of the factory or business day.

Investment as Affected by Load Factor

The cost of energy is made up of two principal elements, the fixed charges and the operating and maintenance expenses. In the case of the fixed charges we must use annual load factor because fixed charges run on year after year. Suppose that one power station has cost \$100 per kilowatt. At 15 per cent per annum the fixed charge per kilowatt would be \$15 each year. With an annual load factor of 30 per cent, the fixed charge per kilowatt-hour would be 0.57 cent. If the load factor is increased to 70 per cent, we find this fixed charge per kilowatt-hour cut to 0.24 cent.

This comparison of course is not wholly a fair one, because a station properly designed to operate at a 70 per cent load factor would cost more to build, although less per kilowatt-hour to operate, than one of equal capacity but properly designed for a 30 per cent load factor. Its boilers would have been rated differently, turbines of different individual capacities and perhaps different efficiencies might have been selected, the condensers would have been designed more liberally and higher-efficiency equipment would have been selected wherever economical with the higher load factor. Even supposing that those features boosted the first cost \$20 per kilowatt, we would still save probably one-tenth of a cent per kilowatt-hour in the combined fixed charges and operating expenses in comparison with an attempt to impose a 70 per cent load factor on a plant properly designed for one of 30 per cent.

The curves in Fig. 1 show the relative costs of energy from a power station designed for a 70 per cent annual load factor when operated at various other load factors. Note at 40 per cent annual load factor the lower cost of energy obtained from a station designed for a 40 per cent annual load factor. The lower fixed charges on the 40 per cent station more than offset its higher operating expenses.

Financial loss will result whenever it becomes necessary to operate a power station at a substantially higher or at a substantially lower annual load factor than the annual load factor for which the station was properly designed. Suppose that the station mentioned previously were one of several stations supplying a light and power system. Assume that at the time of its construction it were intended to operate it on a base load at a 70 per cent annual load factor, whereas the other stations supplying the system were to be operated only to carry peak loads on account of their inferior efficiency. Assume also that within a few years on account of rapid growth of load another larger station, not previously contemplated, were built having greater efficiency and that the station first mentioned no longer were operated on the base load but were operated at a 30 per cent annual load factor. We at once see that we are then using an unnecessarily expensive tool where one costing \$20 less per kilowatt would do the work just as well and at less total cost per kilowatt-hour.

Similar financial losses may occur in a single power station supplying a rapidly growing load. When a new unit is installed in a power station it is important to know approximately how soon another will be required. Each succeeding unit is frequently larger than the preceding ones, up to the practical limit of size available for the particular purpose. The increased size is usually accompanied by increased efficiency. The units of highest efficiency carry the bulk of the load. The extra price paid for extra efficiency in a power-station unit sometimes results uneconomically due to another larger unit being installed earlier than anticipated.

The cost of an error of judgment or the extra expense due to an unexpected change in the annual load factor at which a station or unit is operated may therefore be considerable.

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[1] Stone & Webster, Inc., Mem.Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

Central-Station Location

The location of a central station relative to its raw-material supply and to the point of delivery of its finished product should be influenced greatly by load factor. In the selection of a site, condensing water is usually given first consideration. Transporting it adds greatly to the station fixed charges, while cooling it artificially causes inefficient operation. A very low annual load factor, likely to prevail over a long period of years, sometimes justifies artificial cooling of condensing water if the station may thereby be located near the load with a minimum investment in transmission lines or cable. With a large annual load factor the additional operating expense due to cooling the condensing water might be so large as to entirely outweigh the fixed charge on the transmission line so that the plant would be located where condensing water is available. In weighing the relative costs, the operating expense at either location must be added to the fixed charge before the more advantageous site can be determined.

Selection of Equipment

Load factor determines the quantity of fuel consumed by a power station and has considerable influence upon the efficiency with which it is burned. Starting, stopping and standing by as well as operating equipment only partly loaded, as is required at low daily load factors, inevitably result in a high coal rate.

One of the first problems, if the station be a new one, is to determine the boiler pressure. High efficiencies can be obtained with high boiler pressure. Construction cost, on the other hand, increases rapidly with increases in pressure. The economical pressure should usually be determined by the extent of the use of the equipment, that is, by the annual load factor.

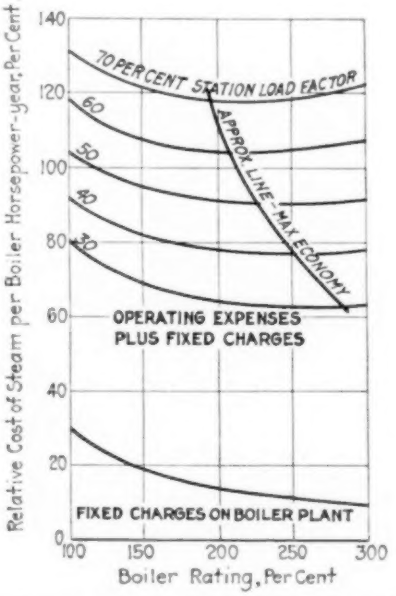


Fig. 2 Boiler Rating as Affected by Annual Load Factor on the Station

An arbitrary assumption of steam pressure or an arbitrary selection of certain principal items of equipment may so definitely restrict the design that the full financial benefits of a consideration of load factor in the later selection of additional equipment may not be realized. The most far-reaching power-station engineering is done during the conception of the project, and it is at this time, when fundamental decisions are being made which will either help or hinder the engineering construction and operation of the station, that load factor should be given the greatest consideration. This means not only the immediate load factors but also the load factors that could reasonably be expected during the probable life of the equipment.

Reference has been previously made to the differences in boiler rating for which central-station boiler plants would be designed for operation at different annual load factors. This depends upon the cost of the boilers and combustion equipment, their efficiencies at various loads, the cost of labor and maintenance at various loads, and the fuel required for banking and starting. Fig. 2 shows for a particular case, selected as an example, the effect of load factor on the most economical rating at which boilers should be operated to carry the station peak load. Note the manner in which this economical rating increases as the load factor diminishes.

The rating is only one of a number of boiler-plant problems that arise which must be solved on the basis of load factor. The type and design of the boiler, the length of its tubes, the number of rows of tubes wide and the number of rows high, the combustion equipment, the location of the bridge wall and the baffles, and the size and shape of the furnace, should all be determined by reference to the total load factor on the station as well as the anticipated load factor on the individual boilers. The use of economizers even in large stations cannot be justified at very low load factors.

The economic selection of turbo-generator units may be made upon the basis of size, speed and other factors. The speed influences both the cost and the efficiency of the unit, and is very important in relation to the average annual load factor at which the machine will operate over a period of years.

The selection of a surface condenser should be made largely from the point of view of the annual load factor. A high load factor anticipated for a unit for a long period of time would justify a condenser of large surface so as to obtain a high efficiency in operation.

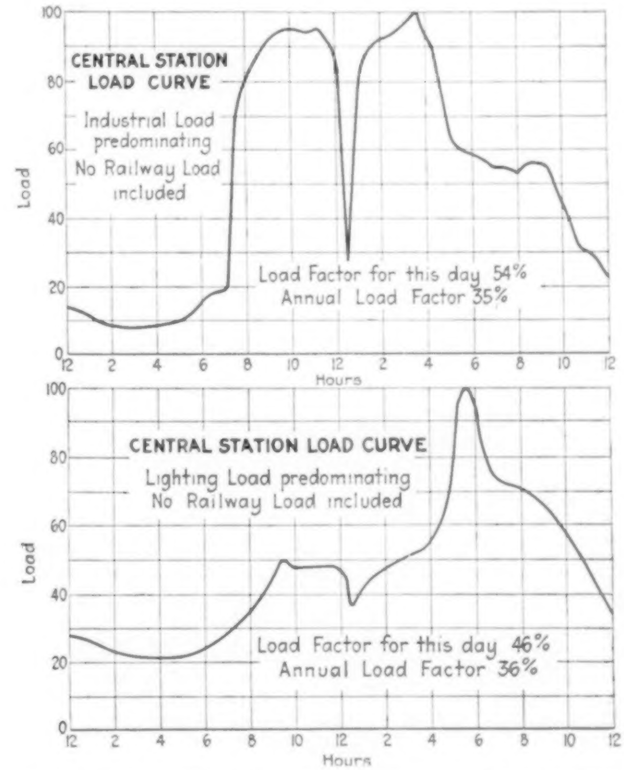


Fig. 3 Typical Week-Day Load Curves and Load Factors

The foregoing does not attempt to mention the many power-station appurtenances contributing to higher efficiency which should be omitted from the station designed to operate at low annual load factor, but which might be justified if the station annual load factor were higher. On the other hand, it should not be overlooked that there are some instances in which it is more economical to buy more expensive equipment for low load-factor conditions than for higher load-factor conditions.

The engineers who design a power station fix the upper limit of its operating efficiency by the selection and arrangement of equipment. If this is properly done for the particular load and load factor, the total cost of power from that station, including the fixed charges upon the investment, will be a minimum if the station is properly operated and maintained. If the selection and arrangement are not made wisely the station thereafter will be handicapped either by excessive fixed charges or excessive operating expenses.

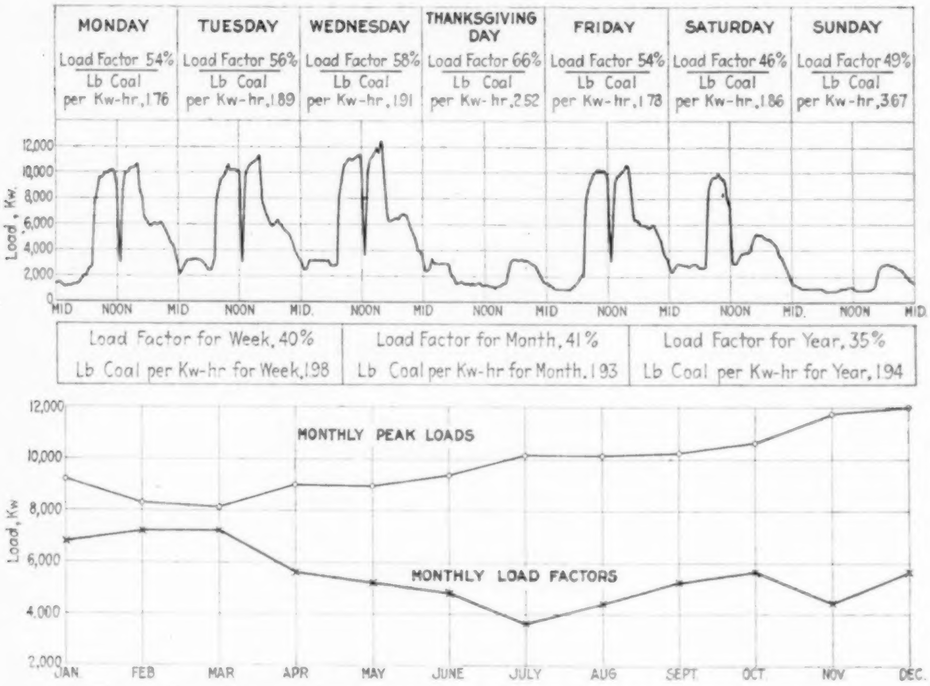


Fig. 4 Load Factor as it Occurs from Day to Day and Month to Month

Operating Expenses

The expense of superintendence and station administration is more or less fixed for a given size of station so that a change of load factor would not influence it in total amount. Boiler labor may be considered as composed of two parts, one of which depends upon the capacity of the station alone, and the other of which, for a station of given capacity, would vary with the daily load factor upon the station. Mechanical labor would be influenced by daily load factor to a less degree but would depend upon the number and size of the main generator units. The electrical labor would be influenced more by the number of feeders or the number of kinds of current distributed than anything else.

Fuel is usually an item of greater expense than all others and, as pointed out previously, it is dependent upon load factor. Efficiency in the use of fuel is greater at the higher load factors. As an example of the effect of load factor upon station operating expenses, a hypothetical case may be taken of a station containing units of various sizes which might have operating expenses as shown in Table 1. Note the fuel expense as compared with the total.

Load factor alone does not by any means determine the amount of fuel which a central station of a given size should consume. The shape of the daily load curve is of almost equal importance in its effect upon the efficiency with which the fuel is burned. The shape of the load curve is in turn dependent upon the character of the business served by the central station. This is illustrated by the two examples of central-station load curve given in Fig. 3. In both instances the lighting peak overlaps the day load, but on account of the predominance of factory load in the business of one of these stations an exceptionally favorable shape of load curve is obtained as well as a relatively high load factor for the day.

TABLE 1 OPERATING EXPENSES AS AFFECTED BY LOAD FACTOR

	Operating Expenses, Cents per kw-hr.		
Annual Load Factor, per cent	30	50	70
Fuel	0.91	0.85	0.71
Labor for Operation	0.10	0.07	0.06
Maintenance, Material and Labor	0.08	0.05	0.04
Miscellaneous, Material and Labor	0.04	0.03	0.03
Total	$1.13	$1.00	$0.84

It is interesting to note, however, that the load factor for the year is practically the same in these two cases. This is due to the effect of the extremely low loads which obtain on Sundays and holidays. For these two conditions, illustrated by Fig. 3, having practically the same annual load factors, the better annual coal rate would be obtained with the one having the more favorable shape of load curve, that is, with the one in which the factory load predominates.

Fig. 4 shows how the load and load factor vary from day to day and month to month for a business in which factory load predominates. The beneficial effect of high load factor on Thanksgiving Day, for example, is much more than offset by the relatively small load on the station on that day. Note how the load factors for the week and for the month are practically the same. The load factor for the year is somewhat lower due to the variation in maximum demand throughout the various seasons. In general the better coal rates are obtained with the higher load factors, although this is greatly influenced by peak load, quality of fuel, and skill in operation, all of which are interesting subjects but beyond the scope of this discussion.

Discussion

In the extended discussion at the Power Session of the Annual Meeting, those whose remarks dealt more particularly with Mr. Junkersfeld's paper were Messrs. Charles Penrose and James T. Enes. Mr. Penrose stated that it is perhaps the foremost duty of the engineer to act as conserver of the natural resources and to obtain the greatest possible economy in power-station design. If this is true, he said, then instead of designing a power plant for existing loads it should be designed for abnormally high loads and then the load should be developed. This could be secured by a combination of circumstances and loads, including railroad electrification, street-railway load and industrial uses. There has been secured, he said, within a short radius from New York City a load factor which at the present time, exclusive of Saturday, Sunday and holidays, has the high figure of 78 per cent.

Mr. Enes referred to the relation between the investment and load factor, which in turn depends upon fixed charges and operating expenses. Since we are now entering a new era of increasing prices, he said, it will be very difficult and perhaps impossible to determine such charges. We have in mind prices and the actual value based on the entire life of the plant. The problem is thus complicated because of the fact that we are now entering upon a period of increasing prices.

POLICIES FOR FUTURE POWER DEVELOPMENT

(*Continued from page 107*)

to bankers of other nations who would take them and sell them to their customers, clients, stockholders, etc., or they would be taken by the construction companies and sold in the same way.

Now that fact of government-issued bonds with guaranteed income at high rates of interest from the start is the inducement that leads the United States bankers to take the securities of foreign stable governments, as they have been doing recently, which funds are to be used for hydroelectric developments that will enable electrification of railroads and industries, and make great savings in fuel. For, what bankers are as a rule looking for is securities that they can take at a profit and recommend to constituents as a profitable investment, either from their own investigation or that of the governments or municipalities they represent.

I believe the United States Government or its Federal Power Commission must do as the foreign governments are doing in order that the funds may be raised for these enterprises. In other words, having sanctioned the enterprises, issued licenses, fixed the rates for interest and for power, guaranteed the efficiency and caused the cost or value to be filed with it, they must go further and find the funds to develop by first finding or arranging for the money to pay the interest, then issuing the securities to be sold to bankers, and they in turn to investors, on the strength of Government backing and guaranteed interest from the start.

Those who provide the money for interest, through taxes or assessments, must expect to get it back in some way, either through enhanced values of property, or improvements, lower rates, cheaper power, etc. The Commission will then have to regulate the use of funds during construction by the engineers and contractors, and lease the enterprises to operating companies for the term of years, specified in the Act.

Scientific and Engineering Work of the Government

By E. B. Rosa,[1] Washington, D. C.

The United States Government is carrying on a very considerable amount of scientific and engineering work through a large number of bureaus located in several different departments. The Agricultural Department is sometimes spoken of as the greatest scientific institution in the world. The Geological Survey, the Bureau of Mines, the Reclamation Service, the Bureau of Standards and other bureaus are well and favorably known for their scientific and engineering work. The importance and economic value of such work is only appreciated by engineers and others who have been brought into intimate contact with such work. Our industries and our civilization are largely based on science and its manifold applications, realized in practice through the various branches of engineering. That the Government should foster science and engineering and cooperate with and develop the industries by means of scientific and engineering research is very generally admitted. There is, however, in the mind of the general public a feeling that this work is not carried on as successfully or as efficiently as it should be, that its distribution and its management could be improved, and that it probably costs too much. This feeling finds expression in the press quite frequently these days, and in terms which lead one to believe that there is a good deal of misunderstanding and misconception regarding the scientific work of the Government, its scope and value and cost. The author has therefore thought it worth while to make a rapid survey of what the Government is doing in the way of scientific and engineering work, how and why it is doing it, what it costs to do it, and, if possible, to answer the question, does it pay?

SOME months ago the writer made a study of the appropriations for all branches of the Government service for the fiscal year 1920. These appropriations were analyzed and classified into six groups.[2] The result showed that for the fiscal year 1920, 3 per cent of the total budget was appropriated for general governmental purposes (legislative, executive, and judicial), 3 per cent for public works, 1 per cent for research, education, and development, and 93 per cent for the army and navy, railroad deficit, shipping board, pensions, war-risk insurance and interest on the public debt, all of which are either obligations arising from the war or for preparation for possible future wars.

In order to get a more accurate knowledge of Government expenditures, and to ascertain how they have increased in recent years, the receipts and expenditures of all departments for the past ten years were analyzed, using the official published records of the Treasury Department for the purpose, but following a somewhat different and more detailed classification. Appropriation bills do not show the earnings or credits to bureaus and departments and hence in many cases are misleading as to the real cost of a given branch of the service. In some cases the whole cost, and in other cases a large part of the cost, is covered by fees or earnings. Examples are the Consular Service, the Patent Office, the Land Office, the Reclamation Service, the Bureau of Navigation, the Forest Service, National Bank examinations, the Federal Reserve Board and notably the Post Office. A "billion dollar Congress" was a familiar phrase in prewar days, but this did not mean that the National Government cost the taxpayers a billion dollars a year. It meant merely that the gross annual disbursements of the Government, including the entire business of the Post Office Department, amounted to a billion dollars per annum. In no single year prior to our entry into the Great War were the net expenses of the Government as much as seven hundred millions of dollars. The important distinction between gross disbursements and net expenses is too obvious perhaps to be emphasized, but it is often overlooked. This study has yielded results of very great interest and value, and throws much light on the question of the cost of government, and whether the civil side of the Federal Government is overdeveloped, and to what extent it is a burden upon the taxpayer.

The Classification Adopted

In order to obtain the relation between the scientific and engineering work of the Government and other Government activities, both as to distribution and expenditures, we may review briefly the organization of the Government, which for the present purpose may be divided into two parts, the civil and the non-civil. The civil side of the Government may be divided into three groups of departments or activities as follows:

- I Primary Governmental Functions
- II Research, Educational, and Developmental Work
- III Public Works (New Construction).

The remaining activities may be grouped as follows:

- IV Army and Navy
- V Pensions and Care of Soldiers
- VI Obligations Arising from the Recent War
- VII Interest
- VIII Public Debt, Loans, and Trust Funds.

Lastly, Group IX includes all revenues of the Government which are derived from direct or indirect taxation.[1]

Disbursements, Receipts and Net Expenses for Ten Years

In order to obtain a correct idea of the actual expenses of the various departments and bureaus of the Government, it is necessary to take account of their earnings and of credits for the sale of Government property, trust funds received and disbursed and of unexpended appropriations turned back into the Treasury. The Treasury Department publishes each year a Combined Statement of Receipts, Disbursements, Balances, etc., of all departments for which appropriations are made, as well as of revenues collected, and these official publications have been used in this study. The ten fiscal years, 1910–1919, inclusive, have been taken, the report for 1920 not being available as yet.

In some cases appropriations greatly exceed actual net expenses, and, on the other hand, certain continuing and indefinite appropriations do not appear explicitly in current appropriations. Fees and fines, proceeds from the sale of Government property and other collections are turned into the Treasury and recorded under miscellaneous receipts, and cannot be expended by the department or bureau collecting them. During the fiscal years 1910 to 1917, inclusive, the amounts of these miscellaneous receipts ranged from forty-five to eighty million dollars each year. In the two war years, 1918 and 1919 taken together, they amounted to over nine hundred million dollars, including several hundred millions for interest on loans to European governments. Expenditures and receipts are distributed among the 106 items of the eight groups, and net revenues and net expenses determined for each item and each group, and the whole added and balanced and checked against the figures given in the summaries published by the Treasury Department. For each year a summary statement was also made for Group IX showing the revenues collected through the customs, internal-revenue taxes, and taxation of national-bank circulation. These are the only revenues resulting from taxation; fees and fines and the proceeds of sales of Government property being credited to departments, as stated above, as an offset to expenses. For example, the fees collected by the State Department or the Patent Office or the Land Office, or the Bureau of Navigation, or a federal court are not intended as taxes for governmental revenue, but rather as fees to cover in part or in whole the expense incurred in rendering a special service or adjudicating a specific case, or as an administrative measure, and are properly credited against the expenses of the given agency. Most, if not all, of these agencies perform public functions and thus render a service to the public as a whole apart from the service to individuals for which a fee is collected. It is thus proper that the public as a

[1] Chief Physicist, Bureau of Standards.

[2] The Economic Importance of the Scientific Work of the Government, *Journal of the Washington Academy of Sciences* vol. 10, no. 12, pp. 341–382. Copies of this paper may be had by addressing the author.

Presented at a Meeting of the Washington Section of The American Society of Mechanical Engineers, December 2, 1920.

[1] The detailed classification adopted is given in the Appendix.

whole should pay for the general service to the public if the individuals served pay for the individual service which they receive. But it is obviously unfair and misleading to charge against a department or bureau the entire expense, and not credit to that department or bureau fees and other earnings or receipts from Government property sold, all of which have caused the expense to be greater than otherwise.

An extreme case of the kind is the Post Office. The Postal Service account is kept separate from the General Fund of the Treasury, and includes all the receipts of post-office business and all expenses other than salaries for the central administration of the Post Office Department, and certain items of a general character. In addition to these overhead items paid from the Treasury, which amount on the average to less than 1 per cent of the postal revenues, the net deficiency or net surplus is transferred over to the General Fund of the Treasury in a single item each year. During the last ten years the total of the surplus transferred amounted to $26,033,448, and the total of deficiencies amounted to $30,890,619. This is in addition to $110,000,000 special war revenue collected while 3-cent letter postage was in vogue. The excess revenue resulting from the extra cent charged, which was regarded as a war tax, was transferred to the General Fund.

The expenditures on the Panama Canal while under construction were included in the Public Works group, but after its opening the cost of routine operation and maintenance together with tolls collected were placed in Group I, while the cost of additions and betterments was included in Group III. The cost of the fortifications of the Panama Canal, however, has been charged in this study to the War Department as a military expenditure. On the other hand, the large sums spent for river and harbor improvements, which are expended by the Army and charged to the War Department in the Treasury account, have been charged in this study to Public Works, on the ground that these improvements are for civil rather than military purposes.

The Reclamation Service has annual appropriations of about nine million dollars, bu it is provided that it cannot expend any more money than is received annually through the sale of public lands and by collections from settlers for lands they occupy or for water received by them for irrigation purposes. Thus the nine-million-dollar appropriation to the Reclamation Service is only an authorization to use the money which they annually collect, or which has been turned into the Treasury by the Land Office, and hence the Reclamation Service costs the taxpayers very little. Some years ago $20,000,000 was, indeed, advanced to the Reclamation Service as a loan, in addition to the receipts from land sales and collections from irrigation projects. This has all been expended and this year a first installment of one million dollars will be paid into the Treasury toward the liquidation of the loan.

The Treasury Department maintains a large force of national-bank examiners, and expended in 1919 more than a million dollars for their salaries and expenses, but it collects and reimburses the Treasury for every dollar of it through assessments upon the banks. It also collects nearly a half a million dollars a year from national banking associations on account of salaries and contingent expenses of the Treasurer of the United States and

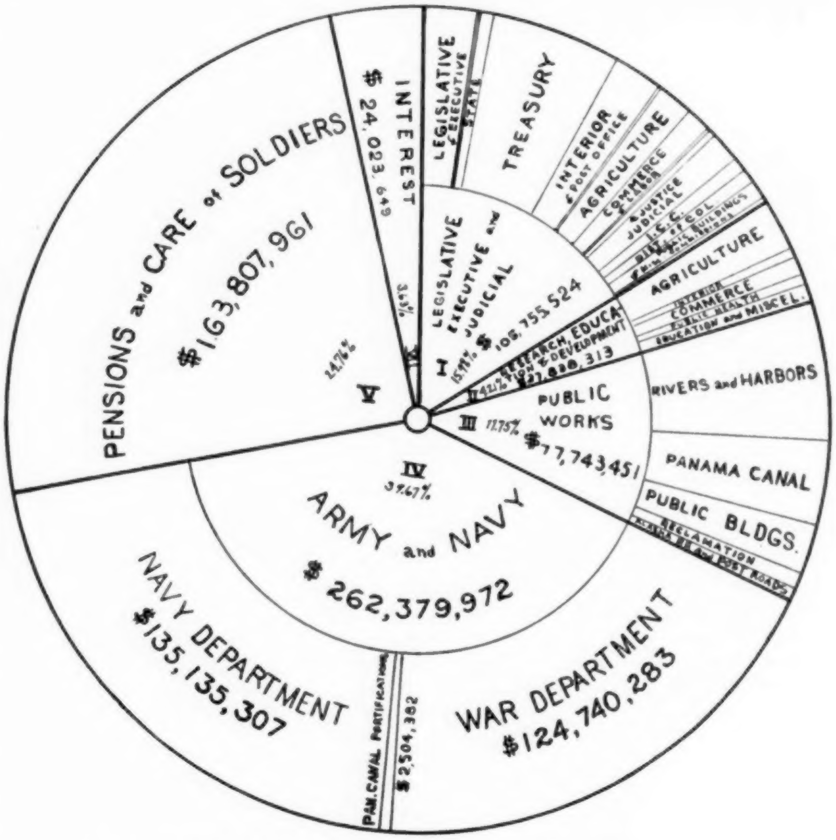


Fig. 1 Average Net Expenditure of Federal Government, 1910 to 1919, Exclusive of War Cost

Average Yearly Total	$661,548,870
Average Yearly Civil	$211,337,288

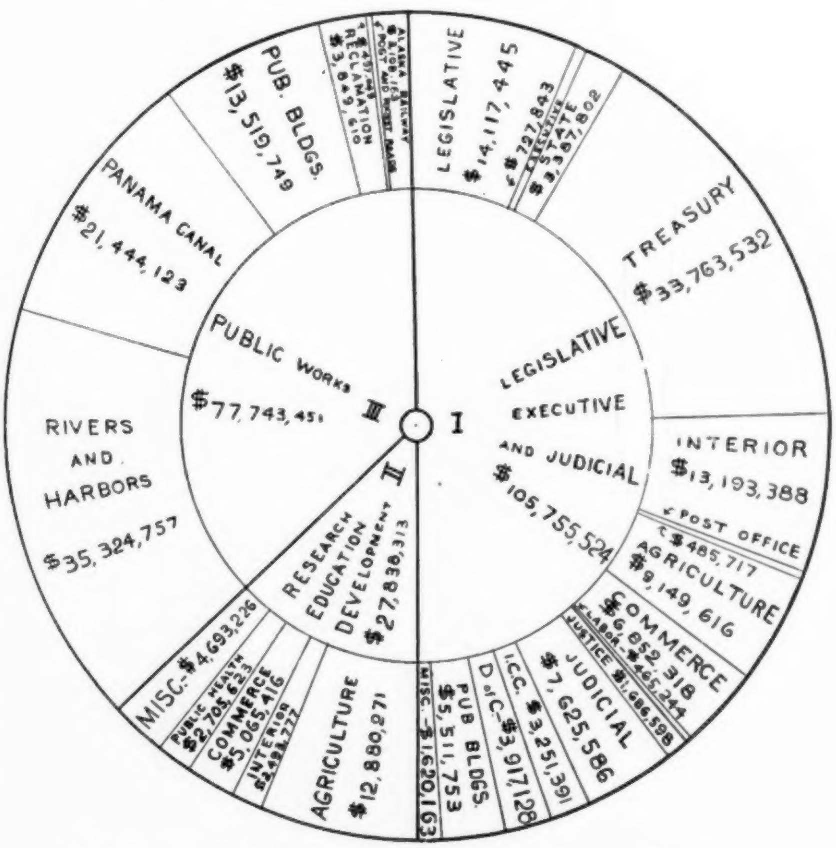


Fig. 2 Average Annual Net Expenditure of Federal Government During the Period 1910 to 1919, for Groups I, II and III—Civil Activities, $211,337,288

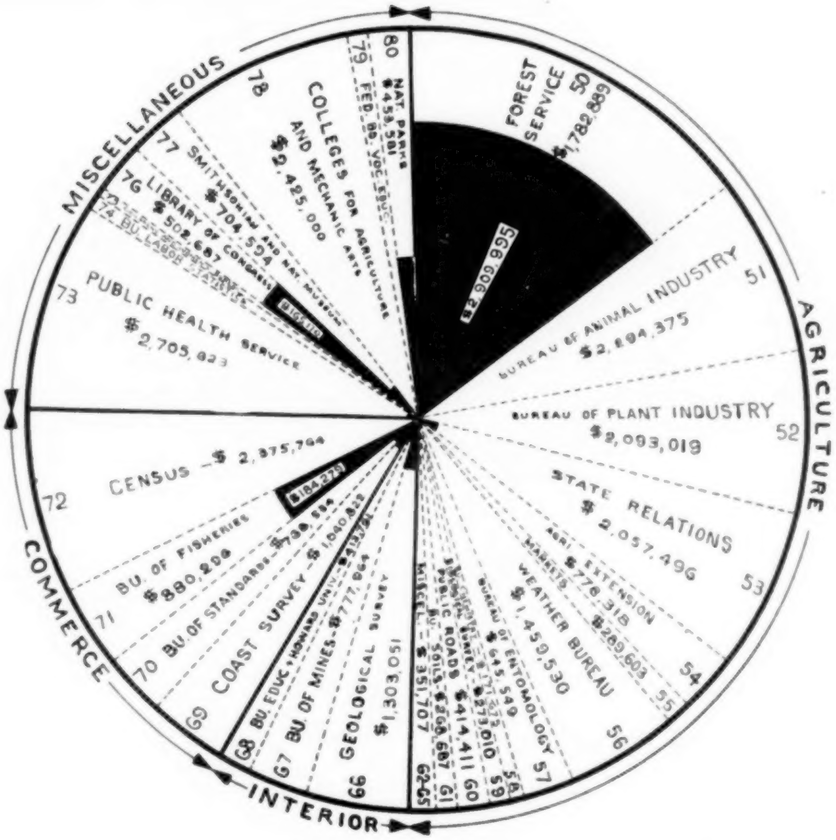


Fig. 3 Average Annual Expenditures and Earnings from 1910 to 1919 for Group II—Research, Education, and Development

Total area of each sector represents gross disbursement; black area represents receipts; white area represents net expenditure.

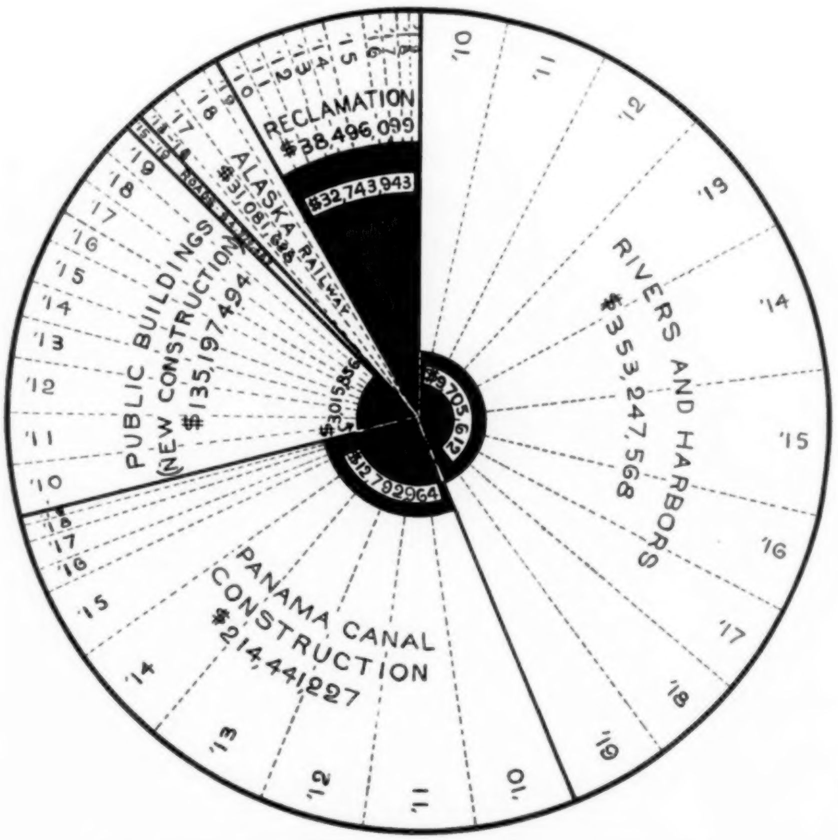


Fig. 4 Aggregate Expenditures and Earnings from 1910 to 1919 for Group III—Public Works

Total area of each sector represents gross disbursement; black area represents receipts; white area represents net expenditure.

the Comptroller of the Currency. The expenditures in 1919, for Indian affairs amounted to $33,320,447.34, but more than two-thirds of this sum was the Indians' own money, which the Government handled as trustee for the Indians. Only $10,500,000 was borne out of taxation as an actual expense to the Government. These examples are given to illustrate the important distinction between gross disbursements and net expenses of the various departments of the Government.

Results of the Study

The results of this study have been collected in the form of numerous tables which have furnished the data necessary for the preparation of a number of charts, which graphically illustrate the results obtained. A few of these charts are reproduced here. This study covers the fiscal years, 1910 to 1919, inclusive, but for the present we are not considering the cost of the war. It was necessary, therefore, in order to show the normal relation between the net expenses of the various groups on a peace-time basis, to exclude *in the non-civil groups all* expenditures arising from the Great War; that is, the expenses for the non-civil groups for the war years 1917 to 1919 were estimated as what they probably would have been if the war had not come, the prewar rate of change being taken into consideration.

The normal relation, on a peace-time basis, between the net expenses of the various groups can best be shown by the average calculated on the above basis for the ten years. The results are shown in Fig. 1. The net annual expenses for the three civil groups, including the legislative, executive, and judicial activities, all the research, educational and developmental work, as well as public works, amounted to $211,337,288—less than one-third of the whole. If we divide this sum by the population of the country at the middle of the 10-year period, 98,000,000, we have the average per capita cost of the civil activities of the Government. This average annual cost to the taxpayer of the civil activities of the Government amounted to approximately $2.15 per capita, divided as follows:

For Primary Governmental Functions (Group I)	$1.08
For Research, Education and Development (Group II)	0.28
For Public Works—New Construction (Group III)	0.79
Total for Civil Activities	$2.15

Since the war the expenses of the Government have increased enormously, and it seems to have been assumed by some that the civil bureaus and departments have increased their activities and expenses in the same proportion as the total has increased. Much has been said and written about the great expansion of the bureaus, and this means or, at least, includes, the civil bureaus; and the need for curbing their growth and cutting their estimates is often emphasized. Some writers, while saying little of their usefulness or the increased need of their services, say much of their inefficiency, extravagance and overdevelopment, and of the duplication of work by different bureaus or departments. These statements are usually made in general terms and without proof or particulars, but they appear to be made in good faith and apparently with the belief that bureau officers are more anxious to expand their functions and spend money than to increase the efficiency and usefulness of their respective bureaus. This opinion is so seriously at variance with what one should expect that it appears worth while to examine the facts in the case.

Fig. 2 shows in more detail the cost of the separate civil activities than is shown in Fig. 1. It will be noted that the legislative, executive, and judicial group absorbed almost exactly one-half of the total for the civil groups, public works represented 36.8 per cent, while 13.2 per cent was devoted to research, educational and developmental work. Expressed in terms of the whole these percentages are:

	Per cent
Legislative, Executive, and Judicial	16.0
Research, Education, and Development	4.2
Public Works	11.7
Total for Civil Groups	31.9

The actual expenditures for all the civil activities are shown for each year in Fig. 5. The variation of the total for any year from

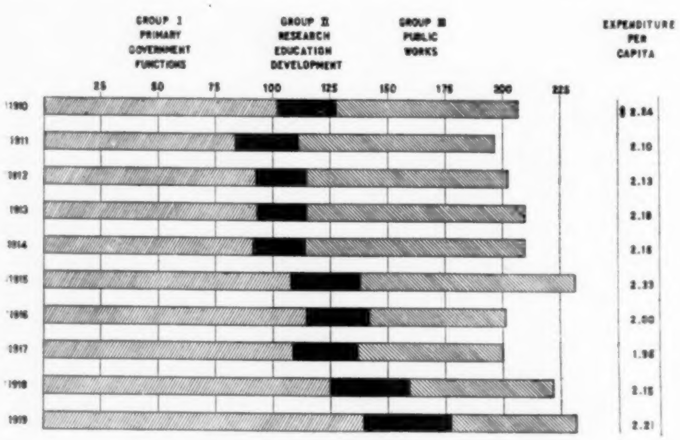


Fig. 5 Allocation of Civil Expenditures of U. S. Government from 1910 to 1919 in Millions of Dollars

the average does not exceed 10 per cent, notwithstanding the fact that general price levels for commodities have more than doubled in recent years and wages outside of the Government service have, in general, risen correspondingly. Particular attention is directed to the fact that no deductions have been made in the expenditures of these civil departments, such as the State and Treasury Departments, which necessarily had to be expanded on account of the war. The per capita net civil expenses are shown in the last column. Attention is also called to the fact that the trend of the per capita costs of the civil activities of the Government was slightly *downward* before the war, with the exception of 1915, which was largely attributable to increases in the net cost of the postal service and immigration service and to a special appropriation of $4,000,000 for eradication of the foot and mouth disease. It is proper to add that there was an appreciable increase in Groups I and II, counterbalanced by a decrease in Group III during the 10-year period.

The relationship between changing wholesale price levels, which largely represent the cost of doing business, and the per capita civil cost is graphically illustrated in Fig. 6. If the cost of the latter were reduced in proportion to the reduction in the purchasing power of the dollar in 1919 as compared with 1910, it would be found that instead of an increase in the cost of the civil government an effective reduction of nearly 50 per cent actually occurred. This largely explains the huge labor turnover in the government service and the reduced efficiency resulting therefrom, as more fully discussed later.

The sources of the revenue of the Federal Government will be of interest. It will be seen from Table 1, the data for which have been taken from the report of the Bureau of Internal Revenue, that while the principal sources of revenue are the income and excess-profits taxes, large amounts are realized from miscellaneous taxes and from customs.

The average net cost for the ten years of the civil activities, including all the research, educational and developmental activities as well as public works, was previously stated as $211,337,288. This is considerably less than the internal-revenue tax for 1920 on cigars and tobacco alone.

TABLE 1 ANALYSIS OF TOTAL U. S. TAXES FOR FISCAL YEAR 1920

Internal Revenue	Net Amount	Per Capita
Income and Excess Profits	$3,957,699,871	$37.20
Cigars and Tobacco	294,813,073	2.77
Transportation and Other Utilities	289,386,302	2.72
Autos, Candy, Furs, Jewelry, etc.	268,480,355	2.53
Beverages	197,353,439	1.86
Special Taxes on Capital Stock, etc.	105,508,052	0.99
Estate Inheritance	103,628,105	0.97
Stamps on Legal Papers, etc.	84,349,027	0.79
Admissions to Amusements, etc.	81,931,781	0.77
Insurance and Miscellaneous	24,925,468	0.23
Customs	307,253,787	2.89
Total	$5,715,329,260	$53.72

Group II The Scientific and Engineering Work of the Government

The members of the engineering profession are, however, more especially interested in the constructive activities, all included in Groups II and III. Figs. 3 and 4 have accordingly been prepared to show in detail the nature of the work and wide range of scientific and industrial research and engineering construction. Gross disbursements, receipts and net expenses are shown on these charts. While Fig. 3 is based on the *average* for the fiscal years 1910 to 1919, Fig. 4 shows the *aggregate* expenditures and earnings during the entire period, together with the relative amount for each year.

The fifteen bureaus of the Agricultural Department constitute the first half of Group II. This work is of fundamental importance not only to farmers and agricultural communities but to the entire population, for an abundant supply of food is essential to the welfare and even existence of the nation and as the urban

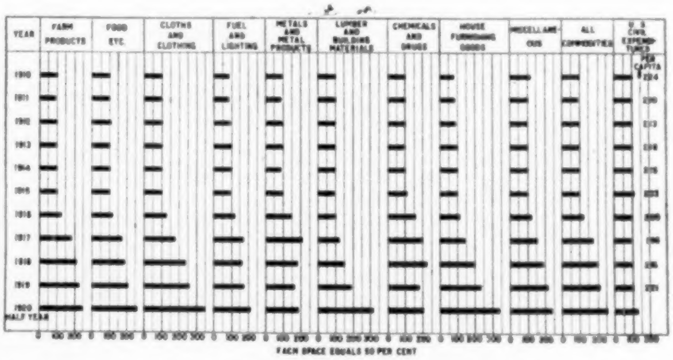


Fig. 6 Wholesale Prices for 1910 to 1920 Compared with U. S. Civil Expenditures
1913 = 100 Per Cent

population increases more rapidly than the rural, the food problem becomes more serious. The total cost of these investigations is not one-tenth of 1 per cent of the value of the agricultural products produced, and there can be no question that the value of the work done far exceeds its cost.

The Geological Survey is one of the oldest of our scientific bureaus and has done notable work of the greatest scientific and economic value. It includes, besides structural and economic geology, topographic surveys and studies of water supply and water power. The Bureau of Mines is an outgrowth of the Geological Survey, and is concerned with all the problems of mining and quarrying and the handling and treatment of their products, and also many phases of the petroleum and natural-gas industry, and the use of fuels. These materials are fundamental to the industries, and work which helps the production of fuels and such important raw materials as metals and minerals is of prime importance.

The Bureau of Education has done important and useful work, but has never been developed on a scale commensurate with the importance of its field. It is believed by many that the Bureau of Education should take a leading part in studying the science of education, and coöperate effectively with the educational institutions of the country in setting standards of education. It would not and could not dominate or control education, and there would be no danger of such a result. But it should be able to coöperate effectively and worthily, and to assist in raising educational standards where they are too low. The Federal Government is now assisting the states to the extent of a hundred million dollars

a year in the building of highways. Why should it not assist in the supremely important work of education by taking a leading part in studying the problems of education?

Four bureaus of the Department of Commerce a e included in Group II. The Coast and Geodetic Survey does fundamental work upon which all other surveys are based, and also does the valuable work of charting the coasts and locating obstructions to navigation. The Bureau of Standards maintains the fundamental standards of physical measurement. It coöperates with foreign governmental institutions in maintaining international uniformity in such measurements. It provides or calibrates copies of standards for states and manufacturers so as to insure uniformity in physical measurements. It develops instruments and methods to secure the highest possible accuracy in measurement and the greatest permanence and reliability in standards. It coöperates with engineering and trade organizations in standardization work, and carries out investigations on the properties of materials to secure data for such standardization. It furnishes information to the various branches of the Federal Government, to state commissions and officers of state and municipal governments, and to the industries of the country and the general public.

Much other valuable work of an educational and developmental character is shown on the Group II chart. The average cost of all this work for the 10-year period was *28 cents per year per capita of the country's population*, certainly a very small sum in proportion to the importance of the interests represented, and also in proportion to the aggregate of the federal taxes collected.

Group III New Construction

The Panama Canal was opened to navigation in 1914. Its total cost for construction and equipment to date is $367,000,000. During the past six years its revenues have amounted to about $34,000,000 and its expenditures for operation and maintenance to $36,000,000, a net deficit of $2,000,000 for the entire period. Had it not been for the slides in 1916, which closed the canal for seven months and greatly reduced the revenue that year, there would have been a surplus of $2,000,000 for the entire period instead of a deficit. The surplus in the fiscal year 1920, amounted to more than $2,000,000, and this should increase year by year. More than $210,000,000 out of the total cost of $367,000,000 was provided out of current revenues of the Government from 1910 to 1915, and hence was included in the $2.15 per capita of civil governmental cost during these years. This is one of the engineering triumphs of the present century, and is another illustration of the successful handling of large public undertakings by the people coöperatively, that is, by the Government.

Another large undertaking of an engineering character is the river and harbor improvements, carried out by the engineers of the army but charged in this study to Public Works. During the ten years, 1910 to 1919, inclusive, more than $350,000,000 was expended in this very important work. From Hell Gate to the Golden Gate, and from Duluth to the delta of the Mississippi, this work has been carried on for many years and is of great aggregate importance.

A third important item in this group is the construction of new public buildings, and during the ten-year period in question $135,197,494 was expended in the construction of post offices, custom houses, hospitals and other Government buildings, about one hundred twenty new buildings per year being erected. The work is done by the office of the supervising architect of the Treasury Department, which for many years has handled this work. This also comes within the total of $2.15 per capita of civil governmental cost, about 79 cents of which was expended in the public-works group. In addition to the construction of new buildings the supervising architect's office has charge of the operation and maintenance of 1300 public buildings in all parts of the country.

The fourth item in this group is the construction of rural post roads, by coöperation with state highway departments. This work has been greatly expanded recently. During the ten years, 1910 to 1919, inclusive, $4,970,489 was expended in the aggregate. But the appropriation for 1920 was $99,000,000, and for 1921, $104,000,000. This is more than the annual expenditure previous to 1920 for the entire range of engineering work included in Group III. The importance of good roads to the proper development of the country is now well understood, and there can be no doubt that the coöperation of the Federal Government will be to the advantage of the people as a whole. The building of roads is an engineering matter in which technical information and experience are of very great importance. The aid of the Federal Government not only stimulates and aids the states, which must pay at least half the cost, but tends to secure the best engineering service and to standardize road construction. It cannot fail to have a great educational influence upon engineers and road builders throughout the country, and to give the users of roads better roads and the taxpayers more for their money than if it is left to individual states. Moreover, in planning and building national highways it is very advantageous to have the Federal Government an active participant, in order to secure a better coördination of effort. As a measure of military precaution and preparedness the realization of a system of good roads on a national scale is of enormous advantage. As a help in getting food to market and supplies to farmers, it is of enormous economic value. As supplementing and in some cases supplanting railroads, such a system of highways is of great significance.

The fifth item is the Alaskan Railway, from Seward to Fairbanks. During the years 1913 to 1919, inclusive, $31,081,628 was expended on this important railway, which, when completed, will be 540 miles long. As with the Panama Canal, this is not an undertaking which private capital would care to undertake. But its ultimate success and its value in the development of Alaska can hardly be doubted.

The sixth item is the Reclamation Service, one of the most profitable and most interesting of the engineering projects of the Government. To reclaim the deserts and to create farms and homes and villages where before was waste and desolation is an inspiring undertaking; and to be able to create wealth far in excess of the cost of the work furnishes a double incentive. Since 1902 the Reclamation Service has constructed irrigation systems to supply 1,780,000 acres of land with water, and storage reservoirs sufficient to supply an additional million of acres. On this reclaimed land 40,000 families are living, and the population of the towns and villages within these projects had increased by as many more. It is estimated that the increased value of the land due to the work of the Reclamation Service is $200 per acre, or a total of more than $350,000,000. The annual value of the crops raised on these lands is estimated at $90,000,000. Most of the money expended on this work is derived from the sale of public lands and the money collected from settlers for the improvements made and the water service rendered.

The Forest Service is akin to the Reclamation Service in that it is developing the public domain. It has been included in Group II, but may be mentioned in this connection. The national forests are located in 29 states in all parts of the country, although the larger portion is in the Far West. There are 152 different forest tracts, with a total area of 156,000,000 acres. The Forest Service has the responsibility of protecting and managing these vast tracts of land; studying how to develop the land best and make its resources most useful to the public. It yields a large revenue each year from timber cut (last year 800,000,000 board feet), and affords on its grazing ranges pasturage for 15,000,000 head of sheep, cattle, horses, goats, and swine. Watching the forests for the outbreak of fire, and fighting fires when they gain headway, is one of the important duties of the Forest Service. Another duty is applying scientific forestry to the development of the forests. Still another is studying the properties of woods and methods of treating and using woods. The Forest Products Laboratory of the Forest Service has done a great deal of valuable scientific and engineering work on a wide range of subjects. In planning its work and in developing the forests the Forest Service takes a long look ahead. Obviously, no commercial company could undertake such a work. The question of early dividends is not paramount with the Government. We have drawn lavishly, even recklessly in some cases, upon our natural resources, and it is well that we should be taking some thought for the future, and should be able to hand down to the next generation our public forest areas in better, rather than worse, condition than they are at present.

The annual earnings of the Forest Service go a long way usually in paying expenses, and it is believed that in a few years they will pay the entire cost of the work, in addition to adding to their value year by year.

The Federal Power Commission is another agency doing engineering work akin to the Reclamation Service and Forest Service in that it is developing the natural resources of the country and indirectly creating wealth. It is different, however, in this important respect, that instead of carrying out engineering work itself, it has general supervision of power sites and their development and will grant permits to private agencies to carry out such work and supervise the carrying out of the work so that it shall not be inconsistent with the public interest. The power problem is a very fundamental one, and the recent unfortunate experience of the industries and public utilities which depend upon coal emphasizes the need for the Government to do what it can to make the water powers of the country available to the industries. It is to be hoped that the Federal Power Commission will be given such means to work with that it will be enabled to attack the problems before it effectively and successfully.

All these important constructive activities of the Government (as shown in Fig. 4) were carried on for the 10-year period at a total cost of $77,000,000 and *an annual cost of about 79 cents per capita of the country's population.* That so much could be done at so slight a burden to each is of course because it is shared by so many. And this is the principal argument in much that the Federal Government does, particularly in research and development work. To do it once well and place the results at the disposal of all is far cheaper as well as better than for separate agencies to do it many times.

Efficiency in the Government Service

How to increase efficiency in the Government Service is an important question, and nobody is more interested in it than those in the service. The problem is not merely how to reduce expenses, or how to get a cheaper government; but rather how to get the maximum of service and the best government possible for a given expenditure. The Government is a great coöperative undertaking for the benefit of all the citizens of the United States. Obviously, ability, integrity, and experience are essential in those who conduct the various branches of the Government. The personnel must not change so frequently that a large proportion of the employees are merely learners, but should be so stable and competent that efficient service can be given. It has been shown that the cost of all the civil activities of the Government during the ten years from July 1, 1909, to July 1, 1919, averaged $2.15 per year per capita for the population of the country, and that during this period the cost increased barely as rapidly as the population of the country increased. At the same time the cost of commodities more than doubled, the cost of living doubled, and the cost of doing private business increased in proportion. Put in other terms, the per capita cost of the civil side of the Federal Government in 1920 was only a little more than half of what it was in 1910 if measured in commodities or in money of equal purchasing power. During this ten-year period the wealth of the country had greatly expanded, the war had come and gone, the problems of government had enormously increased, and yet the per capita cost of these civil activities measured in commodities had fallen to a little more than one-half. In the face of these facts, people are saying that the Government is extravagant, inefficient and overdeveloped. Would it not be fairer and wi hin the truth to say that the civil side of the Government taken as a whole is not subject to such unqualified statements. To be sure, there is inefficiency and incapacity; because salaries in many grades are inadequate, the turnover in the personnel has been excessive. This has tended to make the service in many cases inefficient and unsatisfactory. Too large a proportion of the personnel is inexperienced; too many are learners, and too few thoroughly competent. In some branches salaries are higher than the average and conditions are more favorable; and if at an early date the salary scale can be standardized and appreciably raised (especially where it is below the average), there is good reason to believe that conditions can be greatly improved. Given favorable conditions as to salaries, and an even chance with private business in other respects, it seems safe to expect that an enormous improvement would follow, and that the executive departments of the Government would obtain results both creditable and gratifying. Under such conditions plenty of able men can be found to work for the Government, in many cases at less salaries than the industries pay. And they would be productive and efficient and their work useful and profitable to their employers, namely, the people of the United States. It would be stimulating and inspiring to serve the Government under such conditions. Let us hope that measures under consideration may go far toward realizing these improved conditions, and that the scientific and engineering work of the Government may soon be on a thoroughly stable and satisfactory basis.

Reasons for the Government's Doing Scientific and Engineering Work

The first reason for the Government's doing research work in science and engineering is *for the sake of science itself and its applications, to promote knowledge and advance our civilization.* Research in pure science and its manifold applications is carried on by many agencies. Municipal and state institutions, industrial or endowed laboratories and individuals at their own expense are constantly carrying on and publishing scientific research. For a thousand years governments have taken a leading part in the promotion of learning, and in more recent times in scientific and industrial research. History shows that scientific research justifies itself, and the United States of all countries in the world at the present time should take a forward step in this matter. At the present time and for years to come, scientific research and the cultivation of learning in the countries of Europe cannot be what they were before the war. The enormous national debts of those countries, the depreciation of their currency, the increased cost of living, in many countries the demoralization of industry and in some countries the continuation of war, all tend to retard the resumption of intellectual pursuits and the cultivation of science and learning. Since the war the national budget has greatly increased and the need for scientific and educational work has also greatly increased. We cannot draw upon other countries in future to the extent we have in the past for the results of scientific research. Are we going to recognize and meet the obligation resting upon us as a nation?

The second reason for research is *to aid in making Government efficient and effective* th ough providing as complete knowledge as possible concerning the problems encountered in the administration of the Government, such as those involved in constructing public buildings and other public works, in making public contracts, in inspecting and accepting deliveries on contracts and in collecting the revenue. In all phases of government it is important to have full and reliable technical information. In view of the large interests at stake, and the supreme importance of having the Government maintain a high standard of intelligence, integrity and justice in its dealings with its own people and others, it seems indisputable that generous expenditures made for scientific research for the purpose of aiding the Government itself would be justified.

The third reason for such research is *to benefit industry, to raise the standards of business practice, to increase efficiency, to reduce waste, and to create wealth.* Hundreds of corporations, large and small, maintain research laboratories for the development of their business, and there is no suggestion here that these be discontinued. On the contrary, they will become more efficient and more useful if the Government carries on a large amount of fundamental research work designed to assist them and to make their work more useful and more reliable. It is better and cheaper to have fundamental work done once thoroughly than many times imperfectly. Hence if the Government does a large amount of research work of value to the hundreds of industries that require such information, it will enable them to do their work better and the public that pays all the costs to be better served.

There are many subjects of research in which the industries, through engineering societies and trade organizations, coöperate in carrying out experimental or statistical investigations. There is a great advantage in such cases in having the Federal Government coöperate, to be one of the group carrying out a given investigation, and if possible one of the most active. In many cases

antagonistic interests can be harmonized and coöperation promoted by the presence of the Government. Unfortunately the Government agency most concerned is sometimes unable to respond to such invitations for lack of money. Such work must all be paid for in the end by the general public whether it is all done by the business corporations or some is done by the Government. If the Government participates (in a competent manner, of course), the work will be benefited, the results are more likely to be available to all the interests concerned, and the Government is often able to exert a helpful influence on the industry. Examples could be cited over and over again where this has resulted. Such work is constructive and helpful, and often more valuable in improving commercial practice than the more drastic methods sometimes employed by the Government. Such work by the Government if done adequately would be of enormous value in developing industry and making it better able to compete with other nations. We hear proposals to increase the tariff to give our manufacturers an advantage in our own markets. At the same time we are spending vast sums to build up a merchant marine to carry our products to the markets of the world. We should not therefore forget to do something in a constructive way to help the industries of the country, to increase their efficiency, to reduce waste and costs, to develop new processes and to compete as to quality and cost with the world. Thus will commerce be developed and cargoes provided for our shipping, without which the latter is useless.

The fourth reason for such research is *to furnish reliable information on technical, social and economic subjects in order to aid in securing an intelligent public opinion.* Many injustices to society are prevented or corrected by the force of public opinion without legislation or governmental action. But in order that it shall be an effective and healthful influence it should be an enlightened public opinion. It should be based upon reliable information, scientific, engineering, social or economic. For a government to mislead its people by the dissemination of false information is criminal; to needlessly leave them in ignorance by failing to tell the truth, or failing to secure information that would be of great economic and social value, is unfortunate, to say the least. Education and an enlightened public opinion are essential to the success of a democracy, and much greater attention to science in its broadest sense and to the application of science and the diffusion of knowledge would be of vast assistance in securing such an enlightened public opinion.

The fifth reason for such work is for the purpose *of developing the natural resources of the country and the national domain.* The Reclamation Service, the Forest Service, the Geological Survey, and other bureaus (and just now the Federal Power Commission) are doing work of this kind of great economic value. It is important to discover new supplies of oil or gas or coal or other minerals, to reforest our exhausted timber lands, and to utilize our water powers. It is of equal importance to discover methods of economizing in the use of oil and gas and coal and timber, or of securing by coöperation and education the use of methods already well known. The needless destruction by fire of buildings, the unnecessary consumption of fuel in engines and boilers, the waste of power and of materials which tends to deplete our natural resources, should be studied thoroughly by the Government. Private agencies as a rule are not in position to solve such problems. The Government can afford to take a long look ahead. When 100,000,000 people coöperate in a national problem, the cost upon each is very little and the chances of securing the needed coöperation are vastly increased. Such work pays abundantly in the early future if not in the immediate present, and it will pay again in the more distant future. While using up or destroying our inheritance from the past we should not be unmindful of those who come after us.

The sixth and final reason for the Government's doing scientific and engineering work on a generous scale is to increase the efficiency of the Army and Navy, and to make more effective the preparation of the nation for military effort in the future. Modern warfare is largely a matter of the application of science and engineering to production, transportation, and destruction, all on a gigantic scale. Including the selection, training, feeding and care of men, the development of armament, methods of defensive and offensive warfare, communication and signaling, operations on sea and land, under water and in the air, there is present an infinity of problems, first, for keeping up with progress in all lines of scientific achievement, and second, for making advances and inventions beyond the limits of what is already known. When one considers how vast is the field of modern military and naval activity he can appreciate how useful to the military departments is the scientific work done by the civil establishments if done adequately and well. During the war almost every scientific laboratory in the country was engaged upon military problems. Many worked inefficiently, or to no purpose, but all made serious endeavors and many succeeded. If the lessons of the war are not to be lost, we shall be better prepared next time, and one of the most effective means of insuring that end will be to develop the scientific resources of the Government. If the development of scientific methods and the applications of science are not made in time of peace it will be vastly more costly, if not indeed too late, to do it after war begins. In time of peace such knowledge will promote efficiency, reduce waste and useless experiments and pay for its cost many fold. The military value of a greatly augmented scientific program would abundantly justify its cost, but the same work would in most cases be worth quite as much to the civil interests of the country.

Conclusion

We thus return to the question proposed at the outset concerning the scientific and engineering work of the Government, Does it pay? Does it pay to promote science and learning? Does it pay to have all branches of the Government supplied with full and reliable technical information, and the officers of Government well informed and able to obtain needed information promptly and from reliable sources? Does it pay to coöperate with and build up the industries of the country and develop wealth? Does it pay to supply the public with reliable information and help to create a more enlightened public opinion? Does it pay to develop the natural resources of the country, to reclaim the deserts, and to improve the public domain? Does it pay to have the scientific and engineering agencies of the Government coöperate effectively with the Army and Navy in time of peace, as we have recently learned is so necessary in time of war? To ask these questions is to answer them. It certainly does pay, although time does not permit as detailed and specific an answer to the question as I should like to give. Can we imagine any other expenditure of money of like amount that could pay better? And if the expenditure were greatly increased, would it not probably pay equally well? Would it not lighten rather than increase the burden of taxation? And while developing the country and its industries and benefiting the Government, it would be at the same time promoting science and civilization.

APPENDIX

In the following classification the grouping is by functions, but the order is largely determined by the order in appropriation bills and the Treasury publications.

Group I Primary Governmental Functions, Legislative, Executive and Judicial

Legislative:

1 Senate
2 House of Representatives
3 Legislative, Miscellaneous
4 Capitol Buildings and Grounds
5 Government Printing Office

Executive:

6 President, Vice-President, and White House Staff
7 Civil Service Commission
8 Bureau of Efficiency
9 Tariff and Other Commissions.

State Department:

10 State Department Proper
11 Diplomatic and Consular Service.

Treasury:

12 Administrative, Bookkeeping and Warrants, Clerical and Miscellaneous
13 Auditors, Comptroller, Treasurer, and Registrar of the Treasury.
14 Customs
15 Internal Revenue
16 Coast Guard
17 Bureau of Printing and Engraving

18 Independent Treasury, Mint and Assay Offices
19 Fiscal: Comptroller of Currency, Public Moneys, Loans and Currency, Farm Loans, etc.

Interior Department:

20 Office of Secretary and Miscellaneous
21 Land Office and Land Service
22 Patent Office
23 Hospitals and Relief
24 Territorial Governments
25 Indian Office and Indian Service.

Post Office Department:

26 Post Office Department Proper
27 Postal Service Miscellaneous
28 Postal Service Deficiency or Surplus.

Department of Agriculture:

29 Statutory Salaries and Miscellaneous Expenses
30 Meat Inspection Service
31 Acquisition of Land to Protect Water Sheds
32 Enforcement of Grain Standards, the Pure Food Law, and Animal and Plant Quarantine, etc.

Department of Commerce:

33 Office of Secretary and Miscellaneous
34 Bureau of Navigation
35 Steamboat Inspection Service
36 Bureau of Lighthouses
37 Bureau of Foreign and Domestic Commerce.

Department of Labor:

38 Office of Secretary and Miscellaneous
39 Immigration and Naturalization.

Department of Justice:

40 Salaries, Expenses, and Sundries.

Judicial:

41 Federal Courts and Penal Establishments.

Independent Commissions, Etc.:

42 Interstate Commerce Commission
43 Federal Trade Commission
44 Employees' Compensation and Retirement Commissions
45 Miscellaneous Commissions
46 District of Columbia
47 Panama Canal—Maintenance and Operation
48 Public Buildings and Grounds—Maintenance and Operation
49 Extraordinary Expenses.

Group II Research, Educational and Development Work

Department of Agriculture:

50 Forest Service
51 Bureau of Animal Industry
52 Bureau of Plant Industry
53 State Relations Service (Agric. Expt. Stations before 1915)
54 Coöperative Agricultural Extension Work
55 Office of Markets and Rural Organization
56 Weather Bureau
57 Bureau of Entomology
58 Bureau of Chemistry
59 Bureau of Biological Survey
60 Bureau of Public Roads and Rural Engineering
61 Bureau of Soils
62 Bureau of Crop Estimates
63 Bureau of Farm Management and Farm Economics
64 Bureaus of Horticulture and Insecticide
65 Miscellaneous.

Department of Interior:

66 Geological Survey
67 Bureau of Mines
68 Bureau of Education and Howard University.

Department of Commerce:

69 Coast and Geodetic Survey
70 Bureau of Standards
71 Bureau of Fisheries
72 Bureau of the Census.

Miscellaneous:

73 Public Health Service (Treasury Department)
74 Bureau of Labor Statistics (Dept. of Labor)
75 Children's and Women's Bureau (Dept. of Labor)
76 Library of Congress
77 Smithsonian Institution and National Museum
78 Colleges for Agriculture and Mechanic Arts (Land Grant)
79 Federal Boards for Vocational Education
80 National and District of Columbia Parks; Botanical Gardens.

Group III Public Works

81 Rivers and Harbors
82 Panama Canal Construction
83 Public Buildings, New Construction (Supervising Architect's Office)
84 Rural Post Roads and Forest Roads
85 Alaska Railway
86 Reclamation Service.

Group IV Army and Navy

87 War Department (Except Rivers and Harbors, etc.)
88 Navy Department
89 Armament and Fortifications, Panama Canal
90 Maintenance and Care, State, War and Navy Buildings.

Group V Pensions and Care of Soldiers, Etc.

91 Pension Office and Pensions
92 War Risk Insurance
93 Rehabilitation of Soldiers, Federal Board of Vocational Education
94 Care of Soldiers—Public Health Service.

Group VI Obligations Arising from the Recent War

95 Railroad Administration
96 Shipping Board
97 Food and Fuel Administration
98 Miscellaneous Boards and Commissions
99 Special War Activities.

Group VII Interest

100 Interest on the Public Debt
101 Interest on Loans and Trust Funds.

Group VIII Public Debt, Loans and Trust Funds

102 Public Debt Transactions
103 Loans to European Governments
104 Loans to Farmers, Banks, or Purchase of Stock
105 Seigniorage
106 Trust Funds.

Group IX Revenues

107 Customs
108 Internal Revenue
109 Tax on National Bank Circulation
110 Post Office War Revenue.
(Sales of Government Lands are credited to the Reclamation Service.)

The Fuel Supply of the World

L. P. Breckenridge has submitted the following revised table to be substituted for Table 1 in his article on The Fuel Supply of the World which was published in the January 1921 issue of Mechanical Engineering. This new table gives the figures presented at the Twelfth International Geological Congress held in Canada in 1913.

TABLE 1 TOTAL COAL RESERVE OF THE WORLD IN MILLIONS OF TONS

Eastern Hemisphere:			
Europe:			
Germany	432,356		
Great Britain and Ireland	189,533		
Russia (in Europe)	60,106		
Austria	53,876		
France	17,583		
Belgium	11,000		
All others	28,736		
Total for Europe		784,190	
Asia:			
China	995,587		
Siberia	173,879		
India	79,001		
Indo-China	20,002		
Japan	7,970		
All others	3,147		
Total for Asia		1,279,586	
Africa:			
South Africa	56,200		
All others	1,639		
Total for Africa		57,839	
Oceania:			
Australia	165,572		
New Zealand	3,386		
All other Islands	1,452		
Total for Oceania		170,410	
Total for Eastern Hemisphere			2,292,025
Western Hemisphere:			
North America:			
United States	3,838,657		
Canada	1,234,269		
All others (including Central America)	505		
Total for North America		5,073,431	
South America:			
Colombia	27,000		
Chile	3,048		
Peru	2,039		
All others	10		
Total for South America		32,097	
Total for Western Hemisphere			5,105,528
Total Reserve of the World			7,397,553

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Tidal-Power Development

REPORT on tidal power, outlining scheme for the utilization of tidal power in the estuary of the Severn, which is, next to the Thames, the longest river in England, and where the power available, by reason of the large ebb and flow, is greatly in excess of all the potential sources of inland water power within the United Kingdom put together. For this reason and, prompted by the growing necessity of economizing in the consumption of the national coal resources, the Water Power Resources Committee of the British Board of Trade has undertaken an exhaustive investigation and a scheme for the utilization of such power is suggested in its third interim report published toward the end of last November.

The Committee states that the importance of the project from the national standpoint cannot be easily overrated in view of the magnitude of the power involved, and of the far-reaching character of the economic consequences which would follow the actual development of such a scheme if it could be carried out on sound economic lines.

From data presented, one particular site on the Severn, not necessarily the best, might be rendered capable of developing tidal power representing a saving of from one and a quarter to two and a half million tons of coal per year, and this without even interfering with the navigation in the estuary.

The question is, to what extent can this be actually accomplished? In the Severn estuary the tidal amplitude is large; and the configuration of the estuary is well suited to the purpose in view. The physical characteristics of the land in the vicinity are such as to facilitate the construction of a high-level storage reservoir, while the adjoining industrial district is one in which the power requirements are already large and the power supply is likely to be absorbed completely fo industrial purposes. At the same time, however, there is no tidal-power development of any considerable magnitude in existence and no experience available to serve as a guide.

In view of this fact a sub-committee composed of Sir Philip Dawson and Prof. A. H. Gibson was appointed for the purpose of a preliminary examination of the subject. While this sub-committee has not been able to secure any definite statement of opinion from the leading manufacturers of water turbines and electric generators that would recommend the Severn scheme as a practical undertaking, its members came to the unanimous agreement that it certainly cannot be dismissed as impractical and that a further and more detailed technical inquiry into the subject of tidal power is amply justified and should be initiated without delay. It is therefore proposed to appoint a larger committee for a more careful study of the problem, and an intensive program of investigation for this committee is projected.

What appears to be one of the greatest difficulties in the way of tidal-power development is due to the intermittent character of the service which such a development can give. The report comes, therefore, to the conclusion that if an electrochemical, electrothermal or other process were devised capable of absorbing an intermittent power supply subject to such variations as are inherent in tidal-power generation, the commercial value of tidal power would be greatly increased. Otherwise, it would be necessary to provide means for providing the intermittent output into a continuous supply more or less constant throughout the working period, and such conversion can be accomplished only at the expense of overall efficiency. (Abstracted through *The Engineer*, vol. 130, no. 3390, Dec. 17, 1920, pp. 614–615, *gA*)

Tidal-Power Development, Prof. A. H. Gibson. A technica paper, the author of which together with Sir Philip Dawson constitute the sub-committee of the committee appointed by the British Board of Trade to investigate the subject of tidal-power development, in particular on the Severn River.

The author discusses the several schemes of tidal-power development proposed from time to time. All of these schemes are based on the employment of one or more tidal basins in which dams or barrages are used, either to separate the tidal basins from the sea or from each other. The power is generated by means of turbines which are arranged so as to operate either on the falling tide only or on both rising and falling tides. In accordance with the various schemes employing two basins, the turbines are placed either in the dividing wall between the basins or in the wall dividing the basins from the sea.

The author comes to the conclusion that for an estuary of the type of the Severn, the use of multiple basins is out of the question on account of the cost. The only schemes worthy of serious consideration appear to be those based on the use of a single tidal basin developing power either in the outflowing tide only or on both rising and falling tides, and with the turbines coupled to

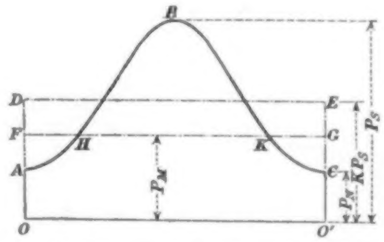


Fig. 1 Curve Representing Tidal Ranges Through one Lunar Cycle

generators which deliver directly into the distributing system when the demand permits of this, and which at other times supply the motors of a pumping station supplying water to an elevated reservoir for which a secondary system of turbines is supplied as required under a constant head.

The following will be found of general interest in connection with the design of tidal-power projects.

Mean Output during a Lunar Cycle. When the tidal range for each day during a lunar cycle is known and the working period and mean head for each day have been settled, the output in horsepower-hours per tide from the primary turbines may be determined and the curve may be plotted on a base representing the number of tides to show the output per tide, as in Fig. 1. The mean height of this curve represents the mean output of the primary turbines over the lunar cycle.

Assuming the curve representing the tidal range to be a sine curve with a mean height of H and a fluctuation $\pm h$ and assuming the working head to be proportional to the tidal range, the output per tide with the given turbine capacity will be sensibly proportional to the square of the tidal range and for any particular tide will be equal to—

$$k(H + h \sin \theta)^2$$

where k is a constant. From this is derived the mean output of he primary turbines over the whole cycle as being equal to—

$$\frac{3(P_S + P_N) + 2\sqrt{P_S P_N}}{8} \text{ hp-hr.} = KP_S \text{ hp-hr.}$$

If, for example, the tidal range at springs is twice as great as at neaps, so that $P_S = 4P_N$, the mean output will be $0.594P_S$, while if $P_S = 8P_N$, the mean output will be $0.51\ P_S$.

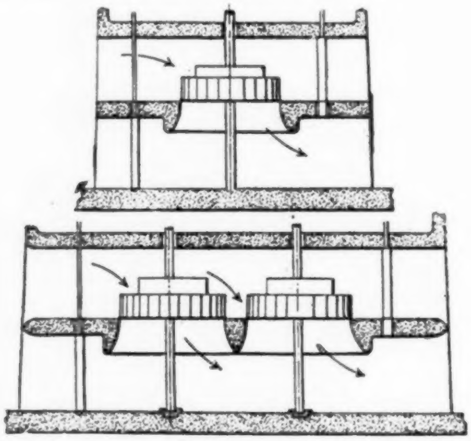
The curve ABC of Fig. 1 represents the output per tide in the clase where $P_S = 4P_N$, while OD represents the mean output per

tide over the cycle. Actually, however, a portion p of the output of the primary turbines is lost in the process in various ways. If q be the fraction of a complete tide during which the primary turbines operate and if P_M be the mean output into the distribution system from both primary and secondary turbines in horsepower hours per tide, then if p be taken as being equal to 50 per cent and if the turbines operate for 5 hr. per tide,

$$P_M = \left\{ \frac{100 - 50}{100 - 20} \right\} KP_S = 0.625\ KP_S$$

With the system of operation involving a 10-hr. working period per tide P_M would equal a value 66 per cent greater than would be obtained if all the output of primary turbines were utilized for storage.

From this the author proceeds to the consideration of the three basic schemes of tidal-power development, namely:



FIGS. 2 AND 3 SETTINGS FOR A DAM IN A TIDAL-POWER DEVELOPMENT

I—Turbines operating on a falling tide only with a constant rate of fall in the basin.

II—Turbines operating on both rising and falling tides with constant rates of rise and fall in the basin.

III—Tu:bines operating on rising and falling tides under the natural difference of head existing at any given instant.

An analysis of the first scheme of operation on a falling tide only with a constant rate of fall in the basin shows that the range of working heads (assuming Severn conditions) is from 25 ft. to 8 ft., and the difficulty of insuring reasonable efficiencies at constant speed over this range would be great. By reducing the working head at spring tides this inequality may be reduced, and by arranging the working period so to extend beyond low tide a greater output may be obtained. By limiting the turbine capacity to that necessary to absorb the energy available at neap tides, the cost of the turbines and of the time in many cases will be reduced to 74 per cent of its original value. This can be done at a sacrifice of only 15 per cent of the continuous 24-hr. output, with economies in several other directions.

The second and third schemes are discussed in detail, the general conclusion arrived at by the author being that the first scheme, which involves operation on a falling tide only, has the disadvantage that the output is only about two-thirds of the output theoretically possib!e with double-way operation (Table 1). On the other hand, the output per unit of turbine capacity is sensibly the same, while it enables a much more efficient type of turbine setting to be used and the number of sluice gates to be halved. It has the further advantage where applied to a navigable river tha' the depth of water in the basin never falls below mean tide level or thereabouts, so that navigation above the basin is improved. The scheme is essentially more simple than any one involving double-way operation, and the balance of advantages would app ar to be heavily in its favor.

Double-way operation under natural head has the disadvantage that the variation in working head is normally very great, while if the conditions be modified so as to reduce this variation the power developed falls off seriously.

Genera' Arrangement of Turbines. In view of the large number of turbines necessary, and of the great volume of water to be handled, the only feasible arrangement, in a large installation, consists of a long dam, which may require to be curved, or to be carried diagonally across the estuary in order to provide sufficient room for the turbines and sufficient waterway for the necessary sluices. A simple type of setting which has been suggested is shown in Fig. 2, and a second type, intended to reduce the necessary length of dam and the number of sluices by installing the turbines in a double bank, is shown in Fig. 3. Owing to the fact that the modern low-speed turbine has of necessity a high velocity of flow through its runner, often amounting to as much as $0.75\sqrt{(2gh)}$, it is necessary for high efficiency to form the discharge passages with easy curves and gradually increasing sections, so as to reduce the loss of energy at discharge to a minimum, and so as to reduce the velocity of ultimate discharge to something in the neighborhood of 4 ft. per sec. For example, with a mean working head of 13 ft. (4 m.) the velocity of discharge from the runner, taking this to be only $0.5\sqrt{(2gh)}$, would be equivalent to a head of 2.5 ft., and the maximum possible overall efficiency of the turbine, assuming

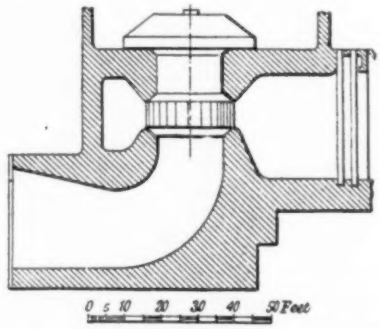


FIG. 4 SETTING FOR A DAM IN A TIDAL-POWER DEVELOPMENT

hydraulic efficiency of 85 per cent in the turbine itself, would be only—

$$0.85\left(\frac{10 - 2.5}{10}\right) = 0.64$$

if the whole of this discharge energy were rejec'ed, as would be the case with either of the settings illustrated. With double-banked turbines the difficulty of obtaining a sufficient waterway area in the face of the dam to insure even such velocities as these is almos insuperable, and would appear definitely to preclude this type of setting.

The only really efficient type is indicated in Fig. 4. Adopting

TABLE 1 COMPARATIVE RESULTS OF WORKING UNDER TIDAL-POWER DEVELOPMENT SCHEMES I, II AND III

Scheme	Method of Operation		Output, Continuous 24-Hour, assuming 50 per cent Losses in Pumping and Storage	Working Period per 25 Hours: Springs	Working Period per 25 Hours: Neaps	Working Heads, Springs: Max	Working Heads, Springs: Min.	Working Heads, Neaps: Max.	Working Heads, Neaps: Min.	Capacity (under a Head of 13 ft.) of Primary Turbines required for the Scheme
I	Falling tide only—with constant rate of fall in basin	(a)	7,680	7.4	6.6	25.0	21.0	9.8	8.0	36,700
		(b)	8,400	12.0	6.6	22.5	8.0	9.8	8.0	33,600
II	Rising and falling tides—with constant rates of rise and fall in basin:									
	All energy absorbed	(a)	13,150	13.0	12.0	11.9	10.0	7.8	6.5	116,000
	Only part of energy absorbed on a rising spring tide	(b)	11,000	13.0	12.0	11.9	10.0	7.8	6.5	68,000
III	Operation on rising and falling tides under natural head		12,400	20.4	13.6	19.0	4.0	6.0	4.0	54,000

this, a turbine capable of developing 3000 b.hp. under a head of 13 ft. would require a spacing of about 52 ft., giving an output, under this head, of approximately 60 b.hp. per foot run of the dam. With smaller turbines the output per foot run of dam would be smaller, amounting to abou 50 b.hp. per foot run for turbines of 2000 b.hp. capacity.

Thus in Scheme I, seventeen turbines, each of 2000 b.hp. capacity would be required, and these wou'd require a dam at least 680 ft. long.

Owing to the relatively large variations in working head in any simple scheme, the question of the most suitable type of genera'ing machinery is one of some difficulty. Under the extreme variations of head occurring in any such scheme, the efficiency of any constant-speed turbine falls off somewhat rapidly, especially at the lower heads, although recent developments of such turbines have shown results which would have appeared impossible only a few years ago. Turbines are now available which are capable of operating under a variation of head equal to 50 per cent on each side of the mean, with efficiencies which do not fall appreciably below 70 per cent over this range, so that this method of operation is quite feasible. It is understood that one well-known firm is prepared to construct variable-speed turbines coupled to constant-speed alternators, and if this can be done without undue mechanical complication and cost, it will probably prove the best solution.

Another possibility consists in coupling the primary turbines to alternators, at a fairly low frequency, and to transmit all the power, through a comparatively short transmission line, to motor-driven centrifugal pumps coupled to synchronous motors. In order to avoid the cost and complication of transformers, the limit of voltage might be that for which the machines can be conveniently wound, i.e., about 10,000 volts. Under these conditions the speed of the primary turbines would be allowed to vary with the working head and the speed of the pumps would vary in the same ratio. In this case multi-stage pumps would be necessary, with provision for adjusting the number of stages in use according to the speed of the primary turbines. This method, involving the storage of all the output of the primary turbines, however, involves a relatively low overall efficiency.

The difficultites of speed variation and electrical regulation could largely be overcome by the use of direct-current generators, which would enable the turbines to be operated always at the speed corresponding to the available head, and under conditions of high hydraulic efficiency, and in view of the possibilities of the Thury scheme of high-pressure direct-current generation and transmission this method must be considered as offering a possible solution.

Another possibility consists in coupling the primary turbines directly to centrifugal pumps discharging into the storage reservoir through one or more conduits or pipe lines. The practical feasibilities of this depends on the topographical features of the site. Where the storage reservoir is not in very c'ose proximity to the dam, and where the head is large, the cost of the necessary conduits would in general be excessive. Moreover, the difficulty of arranging the design of the dam so as to include these would be great It is probable, indeed, that this latter factor would preclude the use of this otherwise simple method in any installation having a long dam and a large number of primary turbines, though it might offer the best solution in a small installation.

For any given scheme it is essential to give full consideration to all the possible mechanical and electrical expedients for developing the power, and to compare these from the view of simplicity, overall efficiency, first cost and cost of operation and maintenance. (*Engineering*, vol. 110, nos. 2867 and 2868, Dec. 10 and 17, 1920, pp. 778–780 and 793–795, 17 figs., *tA*)

Ignition and Cooling in Gasoline Engines—Reports of the National Advisory Committee for Aeronautics

The Fifth and Sixth Annual Reports of the National Advisory Committee for Aeronautics covering the years 1919 and 1920 present a mine of valuable information on subjects connected with the design and construction of aeroplanes and their propelling machinery. As it would be difficult to present even the main conclusions of the work reported in about 1000 pp. of the original documents, attention will be called here only to what might be called the high spots of this important work.

The parts of particular interest to mechanical engineers, in general, are those dealing with the power plant of an aeroplane, particularly as much of the information contained in the report has immediate application to gasoline engines generally and not to aeroplane engines exclusively. The two subjects most extensively dealt with in the report are ignition and cooling in engines. In the field of ignition, again, particular attention is paid to spark plugs. Only one investigation (Report No. 58), by F. B. Silsbee, deals with characteristics of high-tension magnetos.

As regards spark plugs, Report No. 51, by F. B. Silsbee, gives a general discussion of the causes of failure of spark plugs, which are enumerated as follows: 1, Fouling with carbon deposit causing short-circuit; 2, fouling with oil deposit causing open circuit; 3, breaking of the insulator; 4, preignition; 5, conduction through the insulator; 6, electrical puncture of the insulator; 7, minor troubles such as warping and breaking of electrodes, etc.

Experience in the altitude laboratory at the Bureau of Standards and authoritative information received from France indicate that the first type of failure accounts for over 50 per cent of the trouble encountered in practice, particularly at high altitudes, and the third type for nearly 40 per cent; the second type of failure occurs quite frequently when first starting an engine, but very seldom develops after the engine is once running. The other types of failure are of relatively rare occurrence, but must be kept in mind in the design of spark plugs, since departure from the conventional designs is very liable to produce one or another of them.

As regards remedies for these troubles, the author comes to the conclusion that these are so conflicting in character that no general conclusions can be drawn and the design of a spark plug is in every case a matter of balancing opposing conditions to suit requirements in the particular engine considered.

The subject of gas leakage in spark plugs has been investigated by L. B. Loeb, L. B. Sawyer, and E. L. Fonseca.

The method used by the Bureau of Standards for determining gas leakage may be described as follows: The plugs to be tested are screwed into a pressure bomb, which is then filled with compressed air while submerged in a bath of oil heated to any desired temperature. The leakage of air through the plug is measured by the displacement of oil in an inverted bell jar placed over the plug. Standard conditions for testing the relative merits of different types of plugs are 15 kg. per sq. cm. (225 lb. per sq. in.) air pressure and 150 deg. cent. (302 deg. fahr.) temperature.

In the course of this investigation an interesting series of tests was made to ascertain the relation, if any, between leakage and pressure. No definite relation between the variables has been deduced; neither has it been possible to establish any definite relation between temperature and leakage. An effort was also made to determine whether there was on the whole any relation between the design of the plug and its gastightness. From data obtained it would appear that a molded insulator is distinctly superior to the other types in the matter of gastightness, and the good performance of gas plugs is said to be due to their being of molded construction.

The other methods of assembly have been found defective in one or another respect. As regards porcelain and mica insulators, the difference in respect to gastightness has been found to be very slight. It was found, however, that the laminated structure of the mica does not seriously decrease gastightness of the plug, and on the whole it would appear that leakage is more dependent upon workmanship than upon design, as tight and leaky plugs have been found in nearly every design submitted for test.

The question of the comparative temperatures in spark plugs

having steel and brass shells was investigated by C. S. Cragoe (Report No. 52) to determine whether brass is superior to steel for that purpose, because of its greater heat conductivity. The tests were made on an aeronautical motor and also on a truck motor. In the latter case, however, a special cylinder head was used which gave a maximum compression of about 115 lb. per sq. in., which brought the truck motor practically into the aeronautical-motor class as far as temperature conditions were concerned.

The results were somewhat unexpected. The temperatures of the brass shells were found to be considerably higher than the steel in each case. The temperatures in the center of the porcelain were also higher in the case of brass shells. This is explained by the following: The heat received from the hot gases in the cylinder at the inner end of the brass plug is more readily conducted longitudinally to the upper part of the shell, which is thus maintained at a relatively higher temperature in spite of the loss of heat from the upper portions of the shell and insulator by radiation and convection. Since the contact between the porcelain and the plug in the engines tested was above the plane of the engine water jacket, the porcelain was less effectively cooled in the case of the brass plug where the upper part of the metal is hotter, and consequently shows a higher temperature throughout its length.

In this instance the tests can hardly be considered as conclusive, as apparently the design of the engine was such that the good features were carried out on an engine where the spark plug sits in a water-cooled boss, as is the practice in a good many tractor engines.

One of the most important parts of the spark plug, and also the one that is particularly apt to give trouble, is the insulator. Commercially, three kinds of insulators are known: mica; the various insulators produced from talc or soapstone, known under various trade names such as lava, steatite, etc.; and ceramic insulators, generally, though not always correctly, referred to as porcelains. Of these the third class is by far the most extensively used, especially for engines other than aeronautical. The properties and preparation of ceramic insulators for spark plugs constitute one of the most interesting reports published by the National Advisory Committee in relation to the subject of ignition.

The first problem was to develop a method of measuring resistances of insulators at high temperatures, a subject of great importance as the insulator of a spark plug has to withstand the high voltages applied to it mainly when it is heated to quite a considerable extent.

A method has been developed by the Bureau of Standards in which alternating current is used (volt-ammeter method) and tests have shown that successful measurements on a single specimen give results repeating to a few per cent. This method, however, gives results for the material in the unpolarized state, leaving largely open the very wide field of investigation concerning the phenomenon of polarization in spark-plug porcelains. The term polarization, it may be stated, has been applied to a phenomenon the fundamental manifestation of which is that if a constant direct-current voltage be applied to a specimen the resulting current will decrease at first rapidly and then more gradually. If the applied direct-current voltage be then suddenly reversed the initial current in the new direction is found to be approximately equal in magnitude to the original current and much greater than the value immediately preceding the reversal. This implies a counter-electromotive force and is analogous to certain phenomena observed when polarization is present.

The measurements made of electrical resistance of various insulating materials at high temperatures (R. K. Honaman and E. L. Fonseca) have shown that quartz is by far the best of the materials tested as far as resistance at high temperature is concerned, although several of the laboratory porcelain bodies approach this fairly closely. The mica plugs show fairly high resistivity, but it should be noted also that this material loses its water of crystallization at temperatures approaching 1000 deg. cent. and becomes very soft and friable. The steatite and Rajah porcelains from Germany are not notably high in resistivity. The French porcelains, on the whole, have been found to be not as good as the more modern American bodies.

The average commercial porcelain was found not capable of fulfilling the conditions required for spark-plug service nor for any other conditions where high-tension currents are employed and the temperature is considerably above atmospheric conditions. Because of this, an extensive investigation was undertaken (report by A. V. Bleininger), as a result of which porcelains possessing usually high qualities were developed at the Pittsburgh laboratory of the Bureau of Standards. One of the features of one of the porcelains developed was the replacement of the usual magnesia flux by beryllium oxide, which, among other things, is of interest as giving a lower thermal expansion of the porcelain than is the case in feldspathic porcelains. Attempts were also made to replace quartz, for which purpose a number of substances were tried. It was found that such materials as highly calcined kaolin, alumina, zircon or sillimanite, either natural or synthetic, are suitable, the question of selection of any one of these materials being determined by its price or available supply.

Among other things the report gives complete formulas for several new porcelains.

The subject of cements for spark-plug electrodes is covered in a report by H. F. Staley. It was found that cements in spark plugs are a prolific source of trouble. In the first place, they are apt to eat away the nickel electrode wire, or if they hold the wire firmly then they are apt to crack the porcelain due to the difference in the coefficients of thermal expansion of the wire and porcelain.

It would appear, however, that while a cement composed of silicate of soda and raw kaolin was developed that would not destroy the nickel wire, the best construction of a spark plug is the one where no cement is used at all, but instead a mechanical seal is provided at the top of the porcelain to make the plug gastight.

All the foregoing reports deal with the subject of spark-plug construction. Next comes a series of reports referring to the performance of spark plugs, starting with the report by L. B. Loeb and F. B. Silsbee on the effect of temperature and pressure on the spark-plug voltage. J. J. Thomson propounded a theory according to which the sparking potential depends solely on the density of the gas between the electrodes, that is, on the total number of molecules between the electrodes. The Bureau of Standards undertook to investigate whether this law held for pressures and temperatures which might occur in the cylinders of a high-compression engine of the aeroplane type just before the ignition of the charge. In aeroplane engines the maximum compression pressures under normal conditions range from 90 to 130 lb. per sq. in., with temperatures up to 300 deg. cent.

These experiments confirm the relation that the breakdown voltage of a spark gap depends only upon the density of the gas and varies with pressure and temperature only as they affect the density. This relation is found to be valid up to 800 deg. cent. and 8 atmospheres pressure. Both the pressure and temperature of the charge in a gasoline engine increase very greatly during the compression stroke, but the sparking voltage can be computed from the linear relations shown in a diagram accompanying the report (plot 5) without a knowledge of these variables separately, since the density is determined solely by the original density and the compression ratio. For small changes in density, as between engines of different compression ratios, the assumption that the voltage is proportional to the density may be made.

With the sudden discharge from an ignition coil or magneto a disruptive spark is produced even at temperatures where a 60-cycle voltage would produce a brush discharge.

The voltage required for a spark plug set at 0.5 mm. (0.020 in.) in an aviation engine of moderate compression is of the order of magnitude of 6000 volts.

It is by no means certain as yet what governs the ability of a spark to fire a mixture in the cylinder of an internal-combustion engine (incendivity of the spark), but it is without any doubt of considerable interest to know the heat energy of various ignition sparks. The Bureau of Standards has developed a method for measuring this energy and carried out a number of such measurements.

The ordinary spark plug is subject to a good many ills, among them fouling with carbon and oil which are deposited on the surface of the insulation and form a conducting path sufficient to prevent sparks from jumping across the air gap. One of the methods suggested as a relief in such a case was the use of a subsidiary gap, usually in series with the main air gap.

Several such devices have been tested by the Bureau of Stand-

ards, which comes to the general conclusion that addition of a properly designed and operated gap in series with each plug may help in the case of fouling.

Another subject to which a good deal of attention has been paid is that of radiators for aeroplane engines, which is, in a way, of a somewhat passing interest in view of the fact that the general tendency in the development of aircraft engines is toward the entire elimination of indirect cooling.

An extensive report by H. C. Dickinson, W. S. James and W. B. Brown presents a general discussion of test methods for radiators which is of interest also in that it presents a careful analysis of the main factors affecting radiator performance.

The report on head resistance due to radiators is of particular interest to aeronautical engineers. So, in a way, is the report on the effect of altitude on radiator performance. On the other hand, the reports covering results of tests on radiators for aircraft engines give a good deal of information which may be of considerable value also to makers of motorcar radiators.

In these tests it was found that:

1 Heat transfer is a function of mass flow of air, independent of density.

2 Heat transfer is roughly proportional to mass flow for a core having only direct cooling surface. When there is a considerable amount of indirect cooling surface the heat transfer increases less rapidly than mass flow at high air speeds.

3 Heat transfer is proportional to the temperature difference mentioned above.

4 Heat transfer is not greatly affected by the rate of water flow provided the rate is above 2 gal. per min. per in. of core depth per ft. width of core. It should be noted, however, that this is true only when the mean water temperature is regarded as constant.

5 Heat transfer from direct cooling surface is not appreciably affected by the composition of the metal. When fins and other indirect cooling surface are used the thermal conductivity of the metal is important.

6 Heat transfer is somewhat increased, but at the expense of a large increase in head resistance by spirals or other forms of passages which increase the turbulence of the air stream. Heat transfer is greater for smooth than for rough tube walls, for, if the surface is rough, it will be covered with a layer of more or less stagnant fluid.

Electric Melting Furnaces

A HISTORY of the commercial development of the electric melting furnace, and descriptions of the principal types of electric furnaces which are now obtainable on the market for various industrial purposes.

In 1877 Siemens succeeded in melting steel by the use of the electric arc. He devised two types of furnaces: An arc-radiation furnace in which the steel was melted by radiation from an arc between two electrodes located horizontally above the metal; and an arc-resistance furnace in which the steel itself was made one of the electrodes of the arc.

The arc-radiation furnace was subsequently developed by Captain Stassano of the Italian Army, who employed three electrodes coming together in triangular formation above the bath and used a three-phase arc. From forty to fifty furnaces of the Stassano type are at present in operation throughout the world.

There are other furnaces of a somewhat similar character, heated by radiation from the arc. Sometimes the arc is changed a little in shape. Such a one is the Rennerfelt furnace, which is essentially of the same general type, though differing in details. It consists of one vertical and two horizontal electrodes, which project the arc like a blowpipe on the surface of the metal.

There are still other types of the arc furnace. There is the rocking arc furnace, in which the electrodes pass through the sides of the furnace, but the metal is rocked so that it is uniformly heated, thus combating unevenness of temperature caused by intense heating near to the arc. This particular modification of the arc-radiation furnace has been found very useful in the melting of alloys containing volatile metals, such as, particularly, brass.

The arc-resistance furnace was commercialized by Girod, a Swiss electrical engineer. He constructed a saucer-shaped, steel-melting hearth and put through a hole in the bottom of it a soft low-carbon steel rod. The electrode passing through the hearth was 18 in. long; in running it melted 6 in. and left 12 in. solid. This automatically sealed it, and the current was taken away from the projecting end outside, which was water-cooled. The Bethlehem Steel Co. runs a 10-ton Girod furnace at Bethlehem.

Further progress was made by embedding the electrode in the bottom of the hearth. A typical development on this principle is the Heroult arc furnace, in which two electrodes are used. The current passes from one electrode through the slag to the metal, through the metal, and thence back to the other electrode. There are therefore two arcs in series. Nearly two hundred and fifty Heroult furnaces are operated in the United States.

The resistance furnace is a type of furnace which does not use the arc. In it the metal is heated by the resistance of a solid or liquid material. The resistance-radiation furnace is one where the metal is heated by radiation from the resistor, the latter being heated by the direct passage of the current. Another form of resistance furnace operates on what is termed the "pinch effect," that is, the force which, when a current of high density passes through a properly proportioned liquid resistor, causes the liquid metal to be ejected from the center and the cooler metal to flow in from the periphery. Liquid metal in small channels communicating with a larger bath of metal, is heated through its own resistance. This type of furnace has received many modifications, among which is the use of current generated in the tubes by induction, so doing away with electrodes.

Fig. 1 Greaves-Etchells Three-Ton Electric Furnace

The Greaves-Etchells furnace is of the arc-resistance type. The transformers are connected delta on the primary side and Y on the secondary. One of the legs of the transformer is applied directly to the bottom of the furnace by means of copper busbars and a copper plate, which conducts the current through a bottom composed principally of magnesite and dolomite, in such a way that there is a graded resistance, beginning with a low resistance and ending high. The other two legs of the transformer are connected to movable electrodes, which extend down through the roof. Regulation is then maintained by the usual types of furnace regulators. Two voltages are used, the higher voltage for melting down and the lower for refining. Fig. 1 shows a rocking Greaves-Etchells three-ton electric furnace.

By a careful analysis of the conditions described above, it will be noted that the combination of a resistive bottom and the delta-Y connection of transformers is one which prevents serious overload-

ing of one phase, at the same time doing away with a specially high reactance, which is necessary on other makes of furnaces.

Metallurgically, a furnace which uses the bottom as a resistor, and therefore as a heat producer, is superior to one which generates all the heat above the bath. This is especially true of the production of alloy steel, where materials are used which have a higher specific gravity and also higher melting point than the steel itself. Rabbling becomes unnecessary in the Greaves-Etchells furnace, and the roofs last longer, since they are not punished so severely.

The shape of the lining of the electric furnace of the arc type affects its performance very materially, and if not correct may produce cold spots or hot spots in the metal.

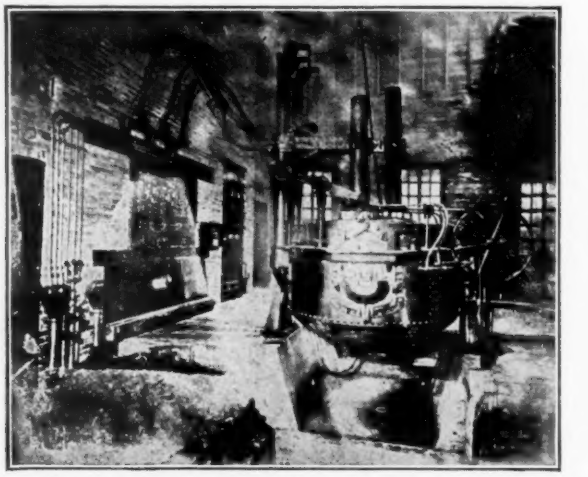


Fig. 2 One and One-Half-Ton Moore Electric Steel Furnace

For a detailed discussion of this subject, reference is made to the original article by F. W. Brooke.

In the Moore rapid "Lectromelt" arc-resistance furnace the tilting mechanism is placed above the floor and the tilting motor is mounted on a bracket to the side of the furnace where it is accessible and out of harm's way from molten steel slag and dirt. There is no mechanism in the furnace pit. The conducting arms of this furnace are also the electrode-supporting arms, a fact which permits placing the insulation between the furnace shell and the arms back at the supporting columns where it is not subject to the rapid deterioration from the heat above the furnace. The inverted dome-shaped bottom of the furnace prevents any possibility of floating the furnace bottom through the expansion of the shell, as the bottom refractories are arched in place. This furnace is designed for the rapid casting of steel, the usual time of melt-down being from one-half to three-quarters of an hour. A $1^1/_2$ ton Moore electric steel furnace is represented in Fig. 2.

An illustration of a Weeks rotating brass furnace is given in Fig. 3. In this type of furnace the metal is melted by the open single-phase arc produced by horizontal electrodes passing through the center axis of the drum. It is necessary in using an electric arc for melting brass to keep the metal thoroughly mixed in order to prevent the zinc content from boiling out, since zinc volatilizes at a lower temperature than the melting point of copper. This has been accomplished by rotating the drum about the electrodes which constantly mixes the superheated surface with the colder metal at the bottom of the bath, thus keeping the bath at a uniform temperature and the zinc so well mixed with the copper that volatilization is a minimum. The Weeks furnace operates single-phase and has for the $^1/_2$-ton size a kilowatt rating of 200 and for the one-ton size 300 kw. The power factor averages around 80 per cent.

An interesting induction furnace of the vertical ring type is the Ajax-Wyatt electric furnace. The construction of this furnace will be readily understood by noticing the sectional views of Fig. 4. In the resistor rapid circulation is obtained as a result of the combined forces exerted therein, namely "motor effect," "pinch effect," and "thermal effect." Each of these forces tends to force the metal upward. The strongest force exerted is that due to "motor" effect which is applied in greatest degree of force at the angle, which is so placed that it is at the extreme bottom of the furnace. The heating and the stirring is all applied from the bottom. No mechanical contrivance is necessary to produce circulation, or mixing. The heat losses are merely those due to radiation, and the small transformer losses. The Ajax-Wyatt furnace has thus far been developed only for melting the copper-zinc alloys. It is possible to handle the full commercial range of such alloys as is used in rolling-mill practice. Development work is progressing in adapting the furnace to other uses, and it is expected that it will shortly be possible to handle all the non-ferrous alloys in this furnace, and possibly some of the ferrous metals. (Symposium in *Journal of the American Institute of Electrical Engineers*, vol. 39, no. 12, Dec. 1920, pp. 1034–1043, 16 figs.)

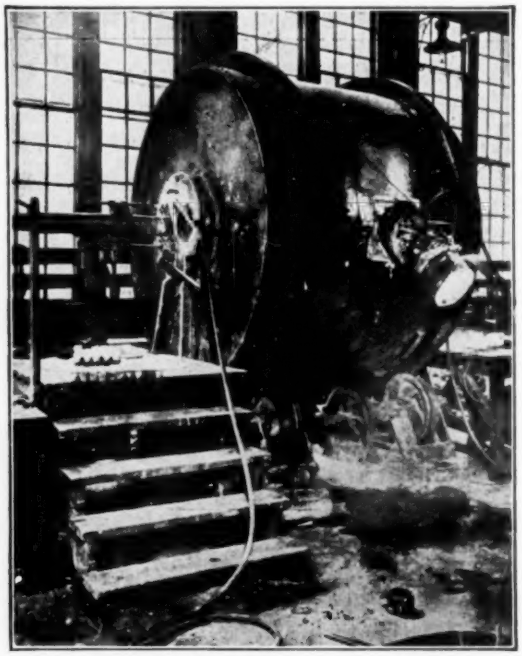


Fig. 3 Weeks Electric Rotating Furnace

A simple type of arc-radiation furnace which can be operated directly on a 220-volt motor circuit, without transformers, has been designed by Frederick von Schlegell, of the Industrial Electric Furnace Co., Chicago. The arcs are drawn, sustained and regulated by a balance system automatically giving stability. The heat element is suspended through the roof, and consists of an

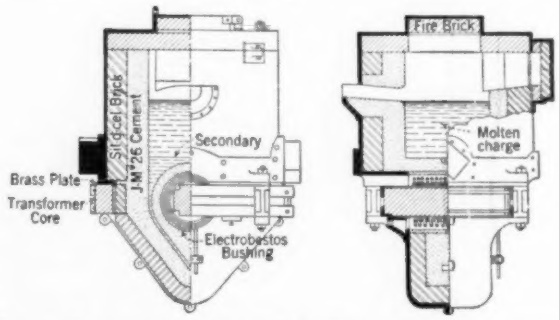


Fig. 4 Sectional Views of Ajax-Wyatt Electric Furnace

electric arc torch, which diffuses a large, intensely hot flame. The shell is cylindrical and of extra heavy steel plate, and is supported on heavy rocker trunnions which allow it to lock after pouring. Tilting is by hand and all mechanical tilting equipment has been eliminated. The furnace is built for single-phase, three-phase or direct current. With single-phase or direct current, two electrodes are used and with three-phase three electrodes. They are held in place by a refractory sleeve so mounted that the sleeve and electrodes can be raised or lowered or swung aside to permit charging through the top opening of the furnace. This does away with side doors and prevents loss of heat. The furnace is lined with an insulating coat next to the shell and a ganister lining mixed with a small percentage of fireclay, and a pine-tar product is ram-

med in place with air rammers. It is stated that this furnace will melt all ferrous and non-ferrous metals. (*The Foundry*, vol. 48, no. 359, Nov. 15, 1920, pp. 929–930, 2 figs. *d*)

Short Abstracts of the Month

BUREAU OF STANDARDS

Steel Rails from Sink-Head and Ordinary Rail Ingots. The object of this investigation was to determine the relation of ingot practice to the properties of rails from such ingots, and in particular to determine the amount of total discard necessary to obtain rails free from piping and segregation above 12 per cent, which have been rolled from steel made in accordance with varying melting, casting and ingot practices.

To that end 35 ingots, made by the converter process at Hadfield's, Sheffield, England, and cast by the sink-head process with large end uppermost, were shipped to Sparrows Point, Md., and rolled into rails; these were compared with 15 rail ingots made in the ordinary manner with the small end uppermost. Each sink-head ingot, of about 5300 lb. weight, and, deoxidized with aluminum in the mold, represented a separate heat of converter steel, and all the heats and ingots were made in the same manner. The composition and properties of these ingots were of remarkable uniformity. The comparison ingots, of 7300 lb. each, were from three separate open-hearth heats, an additional variation being made in the casting and open-hearth practice for each. Five ingots were selected from each of these three heats. Thus, in reality, comparison was made of four different kinds of steel of very nearly the same composition and physical properties, and of two types of ingot form.

The comparison was made by rolling most of the ingots into rails and taking test specimens at each rail cut, as well as from a considerable portion of the upper part, in 5-ft. steps, of the rail bar from each ingot. In this way there was obtained a detailed physical, chemical and metallographic survey of each ingot, and it was possible to delimit exactly the regions of sound and homogeneous from those of unsound and segregated steel. Two complete sink-head ingots were cut longitudinally and examined, as also were representative blooms from both sink-head and ordinary ingots.

The results obtained indicate a decided superiority of the sink-head ingots over the comparison ingots as made of three grades of steel (Tables 17 and 18), although the sink-head ingots suffered from the disadvantage of having gone cold before rolling. The Hadfield type of ingot required discard of only 18.4 per cent on the average (13 per cent top discard to eliminate piping and segregation above 12 per cent), while the average ingot of the ordinary type for rails required a total discard of 43.9 per cent (26 per cent top discard), with great variations dependent upon the furnace and ingot practices.

The comparison ingots from heat M1–M5, made of non-deoxidized rising steel chilled on top of ingot by cast-iron caps, required excessive discard to eliminate positive segregation at the top and negative segregation at the bottom of the ingot, the latter often accompanied by dangerous enclosed pipes.

The second heat (M6–M10), made of rising steel deoxidized with aluminum in the molds, the ingot tops of which were cooled with water, required the least total discard of the three heats. It was more subject to piping and less to segregation than the first heat of ingots made in the usual manner.

The third heat (M11–M15), made of quiet or "killed" steel, was not chilled on top with water or caps and was deoxidized with aluminum in the molds. The ingots of this heat required an intermediate amount of total discard when compared to the first and second heats; this heat was the only one for which a greater top discard was required to eliminate piping than to eliminate segregation above 12 per cent. One of the ingots of this third heat contained a small pipe at the bottom, and all the rails from the middle and bottom of the ingots showed high negative segregation.

The distribution of physical properties throughout the length of each ingot is characteristic not only of the type of the ingot, as sink-head or ordinary, but also of the state of the steel when cast, and of the ingot practice.

It has been established in the foregoing that after removal of the top discard of 13 per cent the Hadfield type of sink-head ingot is free from piping and undue segregation. The ordinary type of ingot, cast small end up without sink head, as is usual for rail ingots, requires an average top discard of 26 per cent, and the remainder of the ingot is liable to contain enclosed piping and excessive segregation. Defective rails, from the middle and bottom portion of the ingot, are not certainly detected by means of existing rail specifications, and as a result of this uncertainty rails containing pipes or excessive segregation may get into service with disastrous results.

The surface condition of the rails from the sink-head ingots was not so good as for the ordinary ingots, but this is not considered an essential characteristic of rails from such ingots.

The markedly differing characteristics of the three heats of comparison ingots leads one to raise the question whether or no it might be advisable to specify, at least in some degree, the methods of steel manufacture or of ingot practice for rails and similar products on which the safety of the traveling public depends.

While it is not claimed that the use of the sink-head process for the manufacture of ingots will solve all rail problems, it is maintained that its adoption would be a step in the right direction in view of the present heavy casualties and property losses on American railroads. The necessary changes in mill operations, it is believed, could be made without too great difficulties. (Abstract of *Technologic Paper of the Bureau of Standards* No. 178, by George K. Burgess, *e*)

The Electric Arc-Welding of Steel: The Properties of Arc-Fused Metal. A fusion weld is fundamentally different from all other types in that the metal of the weld is essentially a casting. The arc-fusion weld has characteristics which are peculiar to it alone. A knowledge of the mechanical properties of the arc-fused metal which is added during the process of welding is fundamental in the study of arc welding. The mechanical properties as revealed by stressing in tension were determined upon specimens (0.505 in. diameter, 2 in. gage length) cut from blocks of arc-fused metal prepared under conditions similar to those met in welding. Additional specimens were also prepared by expert welders outside of the Bureau and submitted for comparison with those prepared by the Bureau.

Two types of electrodes, a "pure" iron and a low-carbon steel, were used. During fusion the composition changes considerably as the carbon and other elements are eliminated and the two types become very much alike in that respect. In each case a considerable percentage of nitrogen is taken up.

The mechanical properties of the arc-fused metal as measured by the tension test are essentially those of an inferior casting. The most striking feature is the low ductility of the metal. All of the specimens examined (about 70) showed evidence of unsoundness in their structure—tiny enclosed cavities, oxide inclusions, and lack of intimate union. These appear to be a necessary consequence of the method of fusion as now practiced. They determine almost entirely the mechanical properties of metal. The observed elongation of specimens under tension is due to the combined effect of the numerous unsound spots rather than to the ductility of the metal.

The material is, however, inherently rather ductile, as may be shown by the changes produced in its microstructure by cold-bending.

A characteristic feature of the microstructure of the arc-fused metal is the pressure of numerous microscopic plates within the ferrite grains. These persist in the metal upon prolonged heating, for example, 6 hr. at 1000 deg. cent. in vacuo were not sufficient to remove them. The various lines of evidence available indicate that they are related to the nitrogen content of the metal.

The microscopic examination indicates that there is but little, if any, relation between these so-called "nitride plates" and the path of rupture produced by tensional stresses. The effect of the grosser imperfections of the metal is so much greater than

any possible effect of those plates in determining the mechanical properties that the conclusion appears to be warranted that this feature of the structure is a matter of relatively minor importance in ordinary arc welds.

Judged from the properties of the metal after fusion, neither type of electrode used appears to have a marked advantage over the other. The use of slight protective coatings on the electrodes does not appear to affect the mechanical properties of the arc-fused metal materially in any way. The specimens were prepared in a manner quite different from that used ordinarily in electric arc welding and so do not justify specific recommendations concerning methods of practice in welding. (Abstract of *Technologic Paper of the Bureau of Standards* No. 179, by Henry S. Rawdon, Edward C. Groesbeck, and Louis Jordan, *e*)

INTERNAL-COMBUSTION ENGINES

Possible Fuel Savings in Automotive Engines, H. C. Dickinson and S. W. Sparrow. Report of tests carried out at the Bureau of Standards. The apparatus employed made it possible to see the acceleration of the engine by means of an acceleration disk mounted on the dynamometer shaft. This was of steel, 33 in. in diameter and 1/2 in. thick. Its inertia added to that of the dynamometer was about equal to that of a 3500-lb. car on direct drive with a gear ratio of 5 to 1 and 32-in. wheels.

Among other things, the tests covered the influence of jacket-water temperature on fuel economy. Two series of tests were made; in the one the temperature of the water entering the jacket was maintained at 162 deg. fahr., and in the second at 72 deg. fahr. Runs were made at full load and at 0.8, 0.6, 0.4, and 0.2

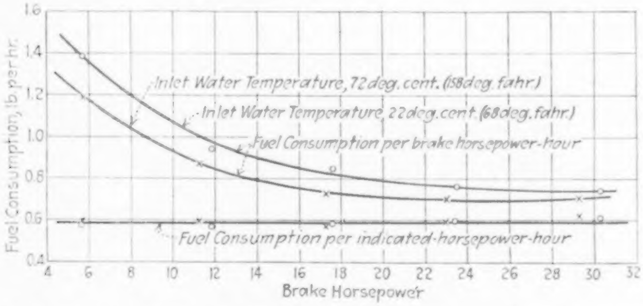


Fig. 1 Curves Showing the Relation Between Fuel Consumption and Jacket-Water Temperature

of full load, with five carburetor adjustments at each throttle setting. From these results the minimum fuel consumption for each setting has been selected and plotted in Fig. 1. From this it appears that the fuel consumption per unit power based on brake horsepower is considerably higher with the cold jacket water.

It may be mentioned, in this connection, that tests made several years ago by J. B. Replogle showed that a very considerable economy in fuel consumption is obtained when the temperature of water is carried to a still higher point than was used by the Bureau of Standards in its test, namely, at the boiling point.

Other tests cover the influence of intake-manifold heating on acceleration and on the maximum horsepower of the engine, it having been found that heat supplied to the charge increases the maximum power of the engine. (Paper presented at the meeting of the American Petroleum Institute, Nov. 17, 1920; abstracted through *Journal of the Society of Automotive Engineers*, vol. 8, no. 1, January 1921, pp. 3–9, 14 figs., *eg*)

MACHINE TOOLS

Improving Efficiency of Twist Drills by Enlarging the Helix Angle

Helix Angle of Twist Drills, Bruce W. Benedict, Mem.Am. Soc.M.E. The operation of the twist drill resembles the action of tearing. The more the action of the tool resembles cutting as opposed to tearing, the more effective the tool is. This condition is secured by increasing the keenness of the cutting edge to a degree that does not result in a sacrifice of its endurance.

As regards twist drills, the author doubts if their manufacturers have attempted to utilize fully the principle of keenness in the cutting edge to the extent permitted by the use of high-speed steel, and with one exception they are producing high-speed twist drills of exactly or of approximately the same cutting angle as was established by them in the days of the carbon-steel drill. In fact, with one exception, milled drills of both carbon and high-speed steel of prominent makers have identical helix angles. (The helix angle as here used is the angle between the cutting face at the periphery of the drill and the axis of the drill and is a measure by which keenness of the cutting edge or the degree of the cutting angle is determined.)

With the exception of one company which markets a special drill having an angle of 32 deg. at the point, the helix angles of milled drills vary between 20 and 26 deg., the majority having angles of either 22 or 26 deg. In many of these drills the helix angle is decreased gradually toward the shank, a total of two or three degrees, so that cutting angles become increasingly blunt as the drills wear.

To determine the most efficient helix angle for use on high-speed

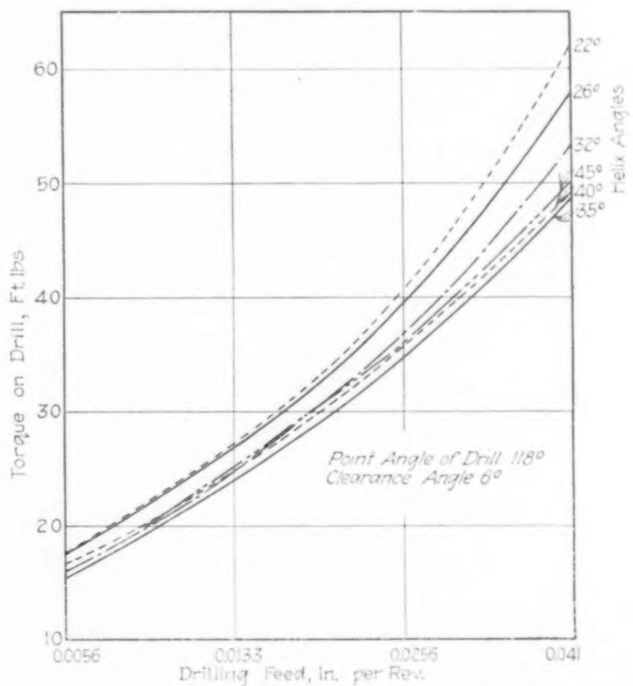


Fig. 2 Power Required to Drive 1-In. Drills of Various Helix Angles at Various Feeds in Cast Iron

milled twist drills, an investigation was carried out with milled drills having helix angles ranging from 10 to 45 deg., 1-in. drills being used throughout.

Data are given in the original article showing the effect of changes in the helix angle on the power required to rotate the drill against the work and remove the chip (Fig. 2), which show a very peculiar variation.

In connection with these curves, the curves of Fig. 3 showing the total end thrust on drills of various helix angles is of considerable interest. Here the thrust decreases progressively as the helix angle increases, reaching the minimum for drills of 45 deg. angle. For certain mechanical reasons, however, it is inadvisable to consider the use of helix angles above 45 deg.

Further tests have shown that the drill with a 35-deg. helix angle retains its cutting edge at least as well as drills with helix angles of 22 and 26 deg. under usual drilling conditions, while it is more efficient in ejecting chips in drilling deep holes than drills with smaller helix angles.

As regards clearance, it has been found that a drill with a helix angle of 35 deg. and a clearance angle of 6 deg. has approximately the same quantity of metal in the cutting end as the 26-deg. angle drill with a clearance angle of 12 deg. (Fig. 4).

As a result of his investigation the author comes to the conclusion that with present design of flute the most efficient milled

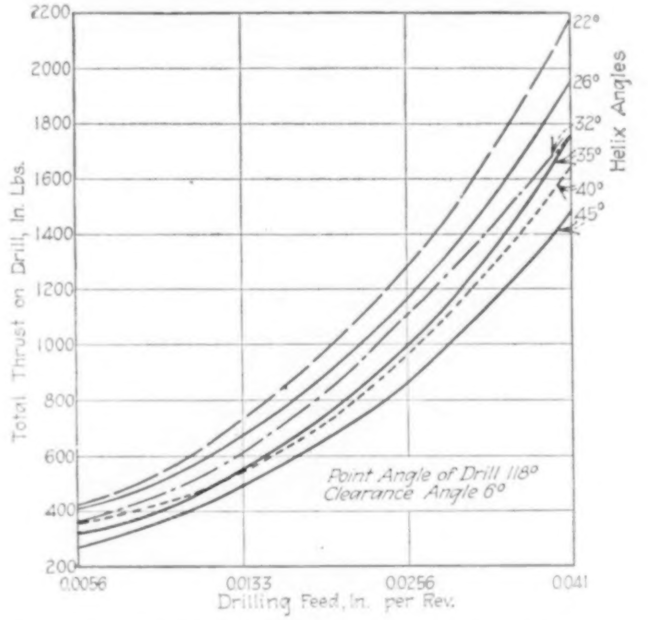


Fig. 3 Total End Thrust on 1-In. Drills of Various Helix Angles at Various Feeds in Cast Iron

twist drill has a helix angle of 35 deg. and that it is possible that development in the shape of the flute will lead to the employment

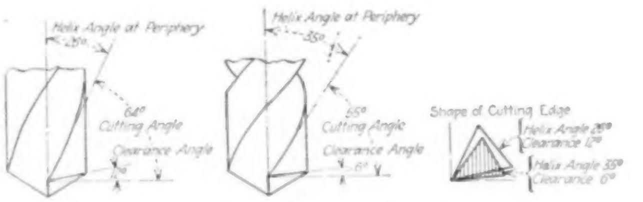


Fig. 4 Comparison of Cutting Angles of Usual and Proposed Designs of Drills

of helix angles above 35 deg. and the attainment of still greater efficiencies. (*American Machinist*, vol. 53, no. 26, Dec. 23, 1920, pp. 1175–1178, 5 figs., *epA*)

Sellers 16-Ft. Planer. Description of a machine tool remarkable for its size and some of the features of design, built by Wm. Sellers and Company, of Philadephia, for a large shipbuilding concern. The machine weighs nearly half a million pounds and is driven by a motor of 75 hp. capacity.

So large is the machine that in order to make its transportation possible it had to be made in several parts and assembled on the spot. This means that it had to be designed and built with particular care so as to make the maintenance of alignment possible.

In particular, the table is 13 ft. wide and was shipped in three lengthwise sections. The bearings on the table, one of which is flat and the other a V, are lubricated by oil delivered by a pump installed for this purpose only, which is, however, the standard practice of Wm. Sellers and Company.

The cross-rail has a span of 16 ft. between supports, which ordinarily might entail a vertical deflection due to the weight of the rail and saddles. In the machine under consideration, however, this is eliminated by giving the rail an extended-back type of construction which makes it very rigid and by the application of an arched girder bolted to the top surface of the cross-rail and provided with a solid abutment at one end and a wedged abutment at the other.

Another difficulty caused by the length of the cross-rail is the tendency of the screws and rods for moving the saddles to sag in the middle. To maintain their alignment, sliding bearings are used. These bearings, three in number, have an automatic latch arrangement which insures one of them being at the center of the cross-rail at all times when neither of the saddles is at that position.

Instead of the ordinary bolts and nuts for clamping the cross-rails to the uprights, the work of clamping is done by pneumatic cylinders, each operating two bolts. The four cylinders are connected to a valve having a selective movement, permitting the cylinders to either open or close. After the cross-rail has been clamped the air passage may be released by the valve, as the clamps are so designed that they will not loosen until air is applied in the reverse direction. This is important, as should the air pressure fail at any time the clamp would otherwise relax and the work might be spoiled.

Other details are described in the original article. (*American Machinist*, vol. 53, no. 22, Nov. 25, 1920, pp. 973–976, 3 figs., *dA*)

MANAGEMENT

An Experiment with Rest Pauses, J. Loveday. Part of a report of the Industrial Fatigue Research Board. While the experiment covered a period of little more than six months, it is of considerable interest. The experiment was carried out at the plant of a firm having two factories, in one of which shoes were manufactured and in the other heels and stiffeners only.

In the stiffener and heel works all the employees with the exception of the foremen were women, the working hours in 1918 being 46 per week. In 1918 the firm found itself confronted with the problem of increasing output without adding new machinery, owing to the extreme difficulty of obtaining machinery at that time. The difficulty arose particularly in the press room where the leather is cut into pieces of the shape required by a mechanical press working upon a heavy knife of the requisite form. The presses are of two types, single and double, a double press being a bench with a press at either end. The operation demands skill and care: flaws in the leather must be avoided and the skin cut with as little waste as possible. The problem has been successfully solved by the adoption of the following plan:

It was determined to make the experiment of working the double presses with a team of three girls, each operative working 40 min. in each hour and resting 20 min., instead of with two girls working continuously throughout the day. It was hoped thus to increase the output of the machine—a hope which has been justified by results. The experiment was begun in January 1919 on a machine with results so favorable that in July six double presses were being operated on this system. A comfortable and attractively furnished rest room, quiet and restful in color, has been provided, and but for the difficulty of arranging for further rest rooms, a difficulty which can only be overcome by building, the plan would already have been greatly extended. There the girls, when they come down from work, are free to rest or to occupy themselves with crocheting, knitting, etc., as they may desire.

Six girls, one for each machine, go to the rest room on arrival at the factory in the morning, and do not start work until 8 o'clock; from then onward the period of rest is 20 min. in the hour throughout the day. Those whose turn it is to rest at 11.40 a.m., and at the corresponding period in the evening, are allowed to go home. The experiment was constituted with the consent of the operatives after thorough explanation, and, though somewhat skeptical at first as to success, they were willing to give it a trial.

The operatives are paid by day rate plus a bonus on output. This bonus is computed by calculating the weekly output of the press and dividing it into three equal parts, so that the three members of each team receive an equal bonus, proportional to the amount of work done during the week.

With the new arrangement a total increase of output on the six presses was obtained amounting to over 44 per cent, and this very high figure is attained with the reduction of the working hours of the individual operative by one-third, and without the addition of new machines. Sufficient data are not available to draw any accurate conclusions as to the actual increase or decrease in output of individual workers, but it would appear that there was such an increase. In particular, it appears that a change benefited especially the comparatively unskilled and the less robust workers, who otherwise would be more liable to fatigue.

As regards the effect on workers, it is stated that at first the girls did not believe the scheme would prove successful, and did not believe they could put out enough in such short hours. Experience, however, reconciled them to the system and none of them at the time of the investigation desired to return to the former hours. This was particularly so in the case of the weaker and less highly skilled girls. (*Report No. 10 of the Industrial Fatigue Research Board, Great Britain*, abstracted through *Engineering and Industrial Management*, vol. 4 (New Series), no. 23, Dec. 2, 1920, pp. 716–718, *gp*)

MEASURING APPARATUS (See Railroad Engineering)

Instrument for Indicating and Recording the Speed of a Railway Train

Recording Speed Indicators, A. G. Newell. While the recording speed indicator might be of great service in railroad operation, as the author points out, there are many elements some of which are of psychological rather than mechanical character which have so far interfered with its useful adoption. Some operating officials are rather reluctant to set a speed restriction and require its observance at all times. Engineers who are not familiar with the working of the speed recorder are also apt to look upon it with disfavor, even though they often change their opinion after becoming familiar with it, as they realize that an instrument of this kind eliminates taking of chances by the other fellow and puts each crew on the same basis.

A speed-recording device on the locomotive is of particular interest as it permits more certain and, curiously enough, more rapid operation over bridges in bad condition, slow track or curves. At present it is the practice of a good many foremen to place very slow limits of speed over bridges and parts of track undergoing repairs, in the expectation that enginemen will not hold their trains to the letter of the order and will in most cases make two or three times the speed that the order calls for, with the result that enginemen obedient to the order go at speeds very much lower than is actually necessary. The correct speed can be set and maintained, however, without difficulty where recording speed indicators are used.

The experience of the El Paso and Southwestern System is described in practice. Their experiments were started in 1907 with a Flaman tachograph brought from France. This instrument gave satisfaction and in 1911 three more of the same make were applied. These four instruments met with such success that it was decided to adopt them as a standard appliance for all road engines on the system. A mechanic was sent to the factory in France and made a thorough study of the instrument. A modern shop for testing and repairing was then fitted up at the general shops at El Paso, Tex. Since then 114 locomotives in road service have been equipped with the Flaman tachograph and there are sixteen reserve instruments on hand.

The apparatus has a speed-indicating dial graduated from zero to 90, each division representing one mile in speed. A small black pointer plays over the face of the dial, indicating the speed being made at all times when the engine is moving in either direction. The lower part of the case contains the speed- and time-recording mechanism and the recording tape, the record on the tape being made by two styles. A sample of a record is given in Fig. 5. The time-recording style rises from the bottom line to the top line in a given interval, which in various types of indicators may be either 10 or 30 min., making a sudden and vertical drop from top to bottom. The degree of inclination of the oblique lines made by the style depends on the speed being made, the greater the speed the less the inclination. During the time the engine is standing the time-recording style will move up in a vertical line or a series of vertical lines, each full line from bottom to top representing 10 or 30 min., depending on the tape used, and each fraction of a line its portion of time.

The mechanism of the instrument is of clockwork type and receives its motion from a series of springs which must be wound by the engineer by means of a small crank before the engine leaves the roundhouse track or at any time after the engine has stood for a period of 30 min. or more during the trip. When the engine is moving in either direction the clockwork is wound automatically by means of transmission rods and gears, receiving its motion from a driving stud and arm attached to the right back side-rod pin and will continue to run for a period of from 30 to 40 min. after the engine has stopped.

The instrument is so arranged that tampering with it is quite difficult. The cost of the apparatus at present is said to be $270 for each instrument and $193 for applying it. The average length of time an instrument will stay in service without repairs is about four months. (*Railway Review*, vol. 68, no. 1, Jan. 1, 1921, pp. 7–10, 4 figs., *d*)

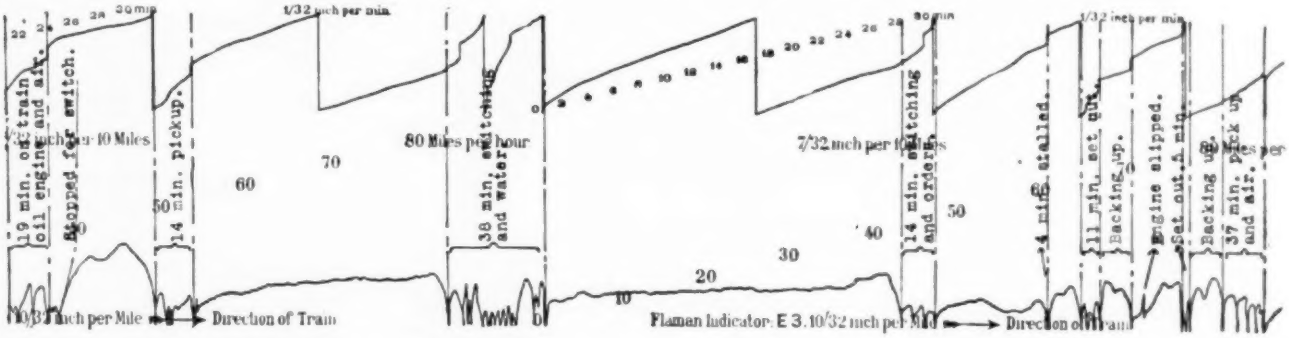


Fig. 5 Sample of Tape Made by a Flaman Tachograph in Use on a Locomotive of the El Paso & Southwestern System

MECHANICS (See Munitions)

MISCELLANEA

Power and Fuel Facts. The following figures are of great interest in that they emphasize in an unusual way the need for fuel conservation:

Prime movers of all kinds in U.S. (stationary and locomotive)	100,000,000 hp.
Used at average load factor of	14 per cent
Used for average period per week	23.5 hr.
Develop per year	125 billion hp-hr.
Water power available	50,000,000 hp.
Coal (without lignite) in ground	2500 billion tons
Petroleum in ground	7 billion bbl.
Used for power only (locomotive and stationary) on basis of present power delivered, resources will last:	
Water power, if all developed	indefinitely
Coal used by best practice	57,000 yr.
Coal used by average practice	7,500 yr.
Petroleum (allowing 40 per cent gasoline)	9.25 yr.
Of prime movers installed:	
Steam plants, coal-fired, make up	52 per cent
Hydraulic plants make up	8.2 per cent
Combustion engines and other types make up	39.8 per cent
Of power developed:	
Public utilities use	42 per cent
Manufacturing plants use	28 per cent
Railroads use	30 per cent
Of 1 ton of coal in the ground, or	2000 lb.
Best recovery brings to the surface	1900 lb.

Average recovery brings to the surface	1400 lb.
Poor recovery brings to the surface	1000 lb.
Power to operate the coal mine takes	100 lb.
Turned into useful work at point of application:	
By best large central stations	608 lb.
By best small central stations	304 lb.
By locomotives, best practice	175 lb.
By small individual plants, average practice	76 lb.

(*Power Plant Engineering*, vol. 25, no. 1, Jan. 1, 1921, p. 1, *g*)

MOTOR-CAR ENGINEERING (See Internal-Combustion Engines)

MUNITIONS

The Aerodynamics of a Spinning Shell, R. H. Fowler, E. G. Hallop, C. N. H. Lock and W. H. Richmond. An extensive paper containing the results, theoretical and experimental, of work carried out by the Munitions Inventions Department for the British Ordnance Committee, on the motion of a spinning shell through air at velocities both greater and less than the velocity of sound.

A description is given of the motion of the spinning shell considered as a rigid body under the effects of gravity or the reaction of the air; this latter is supposed to be known in terms of the position and velocity coördinates of the shell and the state of the air through which it moves. The motion of the shell thus described is then compared with results of experiments and the more important components by the force system imposed by the air are determined numerically as functions of certain variables, such as the velocity of the center of gravity of the shell.

The aerodynamic problem of the motion of the shell alone forms the subject of the investigation and not the general hydrodynamic problem of the motion of the complete system formed by the shell and air together.

The actual experiments consisted of observations of the initial motion of the shell (more particularly the angular motion of its axis of symmetry) over a limited range near the muzzle of the gun. The velocities experimented with ranged from 40 ft. per sec. to 2300 ft. per sec. Using the values of the components so determined, the actual motion of the shell can be calculated with equal certainty in the more general cases which are inaccessible to direct and detailed observation.

One of the interesting parts discovered in the tests is that the spinning shell moves in a manner different from that of the motion of a top. (*Philosophical Transactions of the Royal Society of London*, Series A, vol. 221, no. A 591, pp. 295–387, 15 figs., *tdA*)

PNEUMATIC TRANSMISSION

Laws Governing Closed-Circuit Pneumatic Transmission

Fundamental Properties of Closed-Cycle Pneumatic Transmissions, Jacques de Lassus. The author attempts to establish the laws governing pneumatic transmission operating with a constant mass of gas in a closed circuit, and, in particular, the polytropic transformations occurring in such a transmission. The following notation is used: γ the coefficient of adiabatic or practically polytropic transformation; K the volumetric ratio of the two chambers, capacity and reservoir, or the ratio of the masses of gases initially present in these chambers; M_r and P_r the mass of the gas and the pressure in the reservoir at every instant; M_c and P_c the mass and the pressure at every instant in the capacity; P_i the initial pressure of compression; M_{ci} the mass initially present in the capacity, and M_{ri} the mass initially present in the reservoir.

With this notation the author presents the following laws which he designates as theorems.

Theorem I. In a pneumatic transmission operating with a constant mass of gas in a closed circuit comprising two chambers of given fixed dimensions, the pressure obtaining at each instant in one or the other of these chambers divided by the power γ of the mass of gas contained at the moment in the compartment is a *constant.*

This law may be expressed by the relations $P_c = A\,M_c^\gamma$, $P_r = C M_r^\gamma$, where $A = \dfrac{P_i}{M_{ci}^\gamma}$ and $C = \dfrac{P_i}{M_{ri}^\gamma}$. It is well to call attention in this connection to the fact that this law is not equivalent to and should not be confused with the expression of the result of the experiments of Gay-Lussac and Joule on the flow of gases between two communicating chambers where there is neither assistance from nor protection of external work and where the flow is governed only by the difference of pressures obtaining between the two chambers.

Theorem II. The power $\dfrac{1}{\gamma}$ of the pressure obtaining at each instant in the reservoir added to the power $\dfrac{1}{\gamma}$ of the pressure obtaining in the capacity multiplied by the coefficient K is a constant sum equal to the product of (coefficient K + unity) by the power $\dfrac{1}{\gamma}$ of the pressure at rest or initial pressure of compression. This law is expressed by the formula—

$$P_r^{\frac{1}{\gamma}} + KP_c^{\frac{1}{\gamma}} = (K+1)P_i^{\frac{1}{\gamma}}$$

Theorem III. The volumetric degree of compression ρ at the compressor which is variable at successive stages and which corresponds to any given stage K_n of the ratio of the masses of gas in the two chambers is equal to the inverse of the ratio $K_n \times$ the constant factor K. Moreover ρ is independent of the initial pressure of the charge.

$$\rho = \frac{K}{K_n}$$

Theorem IV. The value of K_m, which is the ratio of the masses of gas respectively contained in the capacity and the reservoir in a state which corresponds to a maximum output of work per revolution of compressor, is a function exclusively of K and of the coefficient γ of transformation.

$$K = \frac{\gamma^{\frac{1}{\gamma-1}} K_m}{[1-(\gamma-1)K_m]^{\frac{1}{\gamma-1}}}$$

From this law one can see that the ratio ρ_m which corresponds to the maximum couple at the compressor is a function of only K and γ.

Compensation of Leakages. If we raise to the power γ the two members of the formula which express the second law and if we express the first member in the form $P_r\left(1+\dfrac{K}{\sigma}\right)^\gamma$, we obtain a binomial expression $(X+1)^m$, where X, which is a variable, has its values comprised between 0 and 1 if K is, for example, less than 4. Since m has a value not in the immediate neighborhood of unity, we arrive by developing the expression in a Taylor series at an expression $P_r + MP_c$ = constant, where the coefficient M has a value close to K raised to the power of γ.

This expression means that if we act on a piston in two stages of which the sections are in the ratio M with the pressure P_r constantly applied on the smaller section and the pressure P_c constantly on the large section, the piston will remain in equilibrium under the action of constantly applied opposed forces. This device makes it possible to insure the invariability of the gaseous mass in the circuit. As soon as a noticeable leak occurs or as soon as the average internal energy of the gaseous mass tends to deviate at any prevailing state from the scale of values established by the theory presented above, the two-stage piston becomes immediately possessed of a tendency toward displacement in one or the other direction, and its displacement may then be used to provide a communication respectively between the capacity or reservoir and a charging or exhausting compartment, according to the direction of the displacement of the piston. Such a piston insuring the invariability of the gaseous mass in the circuit and having the ability to return to its position of rest whenever the cause of disturbance disappears, is called a "pneumatic balance." At all states of operation it plays the double rôle of a device for automatically compensating for losses and of governor in the operation of the circuit.

Operation under Different Initial Potentials. If the regulation of the distribution of the receiver is constant, then in accordance with the third law the same ranges of velocities and couples will be obtained with the same apparatus, no matter what may be the

initial potential of the charges; that is, no matter what may be the power which the group must deliver for a given velocity of the compressor. In other words, the apparatus is absolutely comparable with itself, no matter what may be the value of P_i; in particular (Theorem IV), the maximum of the motor couple at the compressor preserves the same location between the extreme points in the operation of the transmission. Therefore, within practical limits determined by the strength of materials employed, the same transmission may be used for a wide range of power, simply by varying the spring or the counter pressure of the pneumatic balance in such a manner as to modify the constant of its equation of equilibrium without, however, changing the average position of equilibrium of its balance; that is, without changing anything in the arrangement of the different organs of the apparatus. (*Comptes Rendus des Seances de l'Academie des Sciences*, vol. 171, no. 21, Nov. 22, 1920, pp. 992–995, *tA*)

STEAM ENGINEERING

Tests of the Unaflow Pumping Engine, D. A. Decrow. Description and data of tests carried out on an experimental engine with a view to determining certain factors. The engine is a single-cylinder, horizontal crank-and-flywheel pumping unit of the extended type having a nominal capacity of $2^1/_2$ to 3 million gallons in 24 hours. The engine itself has a steam cylinder $13^1/_2$ in. in diameter by 21 in. stroke.

The main data are presented in the original article in the form of tables and the results would appear to indicate that the permissible speeds of this type of engine are much higher than is considered advisable for other types of crank-and-flywheel pumping engines. The results of the steam economy would also indicate higher economy for the higher speeds and temperatures. (*Journal of the New England Water Works Association*, vol. 34, no. 3, Sept. 1920, pp. 195–199, *e*)

TESTING APPARATUS

Junkers Water-Eddy Brake. Description of a water brake of the eddy type employed in the testing laboratory of Doctor Junkers for testing oil engines with a power output of the order of 1000 hp. Essentially, the brake consists of the rotor A (Fig. 6)

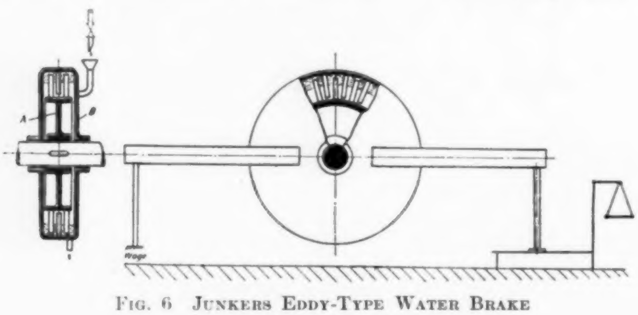


Fig. 6 Junkers Eddy-Type Water Brake
(*Wage* = Scale)

keyed on a shaft and a stator B located centrally with respect to the shaft. The stator and rotor are provided along their peripheries with finger-like attachments arranged in a certain manner, water being circulated between these attachments. If now the rotor A be set in rotation the water between the finger-like attachments offers a resistance which converts the energy supplied by the motor into heat, and this heat is in its turn carried away by the water. The brake has therefore no solid parts rubbing against each other. The thickness of the water rings determines the output which the brake is capable of handling and the regulation is carried out in a very simple manner by varying the level of the water rings, this being done by regulating the water inlet and outlet valves. Preferably the water admission is so regulated that no steam is produced, as this would make conditions in the test room unpleasant.

If water is admitted at 10 deg. cent. (50 deg. fahr.) and discharged with an outlet temperature of 65 deg. cent. (149 deg. fahr.) then the brake will require 636/55 = 11.6 kg. [2545/(149–50) = 25.7 lb.] of water per b. hp-hr. The brake is equally suitable for all kinds of motors, outputs and speeds. Thus the original article illustrates a brake of this type applied to the testing of an exhaust-steam turbine of 6400 hp. at 210 r.p.m. Another illustration shows a 600-hp. Diesel motor, etc. One of the advantages claimed for this brake is that it prevents the engine from running away under any conditions whatsoever. (*Wirtschafts-Motor*, no. 9, Sept. 1920, pp. 19–20, 5 figs., *d*)

VENTILATION

Determination of Dust Content of the Air in a Room

Theory of Dust Action, O. W. Armspach. Report of investigations on air dust and its determination carried out jointly by the research bureau of the American Society of Heating and Ventilating Engineers and the United States Bureau of Mines.

Dust for the purpose of the investigation is defined as particles of matter so finely divided that they easily remain suspended in air, and the velocity of fall is comparatively low. They are considered as spheres. The length of the time that a particle remains in suspension depends upon its diameter, its density, and the density and viscosity of the air.

The following important conclusions have been established:

1 The dust content in a room depends upon the density of the material, velocity of fall of the particles, and the size of the room; the dust will accumulate until a definite content is reached, depending upon the rate of fall and the number of air changes,

2 The total dust given off by various machines when handling different materials can be determined from the average count resulting in the room;

3 Dust conditions can be greatly improved by providing the proper number of air changes; there is, however, a limit to this number and usually five changes per hour are sufficient;

4 For equal conditions of air dustiness, as the density of the material increases, the weight per cubic foot decreases;

5 All dust determinations should be on a basis of the number of particles per cubic foot.

A formula is derived for the velocity of fall of dust particles in terms of their radii and density and the density and viscosity of air. A chart constructed from the formula for various kinds of dust is represented in Fig. 7. It will be observed, for example, that a particle with a diameter of 2 microns and a density of 8, will fall at the same rate as a particle having a diameter of 5.75 microns and a density of 1. With a constant density the velocity increases as the size of the particle increases, and the increase in velocity becomes greater as the diameter becomes greater; that is, for the larger particles the friction of the air is less effective and the velocity of fall more nearly equals that due to gravity. Fig. 7 further shows that the density of the dust particle is an important factor when the conditions of air dustiness in a room are considered. Particles of iron dust 2 microns in diameter will fall at a rate of 12 ft. per hour, whereas particles of wood dust of the same size would fall only $1^1/_4$ ft. per hour. Therefore, when equal quantities of wood and iron dust are produced in different rooms, the conditions of air dustiness in these rooms will differ considerably. The average size of the particles in a steel-grinding establishment will be very much smaller than the size of the particles in a furniture factory, and the means of controlling the dust as necessary to maintaining desirable conditions in the various establishments must be compatible with the fineness and the density of the material handled.

It follows that the average dust count in a room will depend upon the kind of material, the conditions at the source, velocity of fall, and the length of time that the dust-producing machines have been in operation. Formulas are derived and graphs constructed indicating the number of particles of various kinds of dust in a cubic foot of air in a room of given capacity with equally unfavorable conditions at the source. It is thus determined that the heavier dusts reach the maximum-content conditions early in the day, while for wood and other lighter materials the dust content continually increases even after the tenth hour is reached. A dust count alone is therefore not sufficient when designing a

system of ventilation, but attention should be given to the size of dust particles, the size of the room, and the relative time the particles of dust remain in suspension.

So far the effects of the conditions at the source of dust and the velocity of fall of the particles have only been considered. In addition, there is a decrease in the dust content due to the change of air in the room. This change may result from natural infiltration of air from outdoors or by exhausting the air from the room by mechanical means. When air leaves the room, each cubic foot carries with it a certain number of particles, depending upon the dust content in the room. Also an equivalent amount of air must enter the room. There is therefore a continuous process of dilution taking place, and the dust content in the room

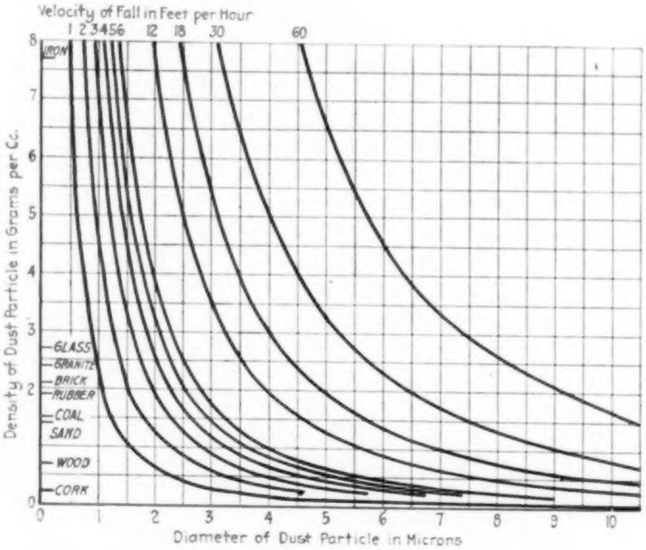


Fig. 7 Chart Showing Velocities of Fall for Various Kinds of Dust

is decreased. When the dust leaving the room due to the air change, plus the dust falling from the room, is equal to the total dust liberated, the conditions are balanced and the dust content in the room remains constant. Fig. 8, also constructed from a formula, shows the effect of changing the air on the dust content. The curves have been plotted for dust 2 microns in diameter falling with a velocity of 1 ft. per min., and 100,000 particles per

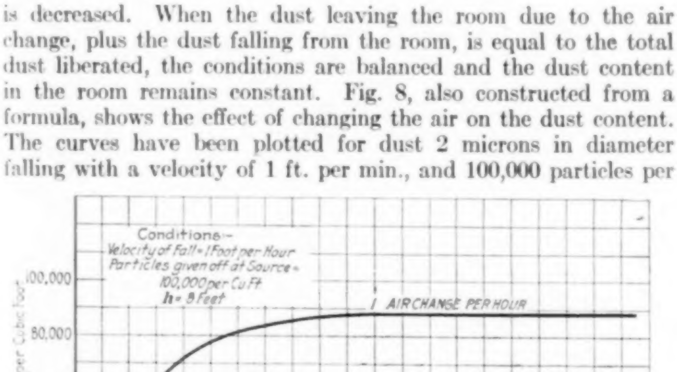


Fig. 8 Curves Showing Effect of Air Change on Dust Content

cu. ft. per hour are given off at the source. Note that with one air change the result in the room at the end of the fifth hour is 88,000 particles per cu. ft. With two air changes the result is only 47,000 particles. If no air is allowed to enter the room the result will be 389,600 particles per cu. ft., or an increase of 342 per cent over the result obtained with one air change.

It will be readily seen that counting methods are superior to weight measurements in air-dust determinations. It is possible to have very different weights for the same conditions of dustiness with different dusts. For example, the weight of 100,000 particles of iron dust of a size which could cause them to fall at the rate of 6 ft. per hr. is approximately 0.0011 mg., while the weight of the same number of particles of wood dust producing the same conditions of dustiness is 0.004 mg. In general, the lighter the material, the greater must be the weight per cubic foot to result in equal conditions of dustiness. Thus a dust determination based upon weight is extremely misleading. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 26, no. 9, Dec. 1920, pp. 819–829, 6 figs., *t*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

Attaining Normal Grinding Speeds With Extremely Small Wheels

A grinding-wheel spindle designed to operate at 104,000 revolutions per minute was exhibited at the recent London machine-tool exposition. *Machinery* for January 1921 describes this spindle, which is equipped with a wheel 1/4 in. in diameter, attaining, therefore, a cutting speed of about 6800 ft. per min. It is the product of the A. A. Jones & Shipman Co., Leicester, England. The drive is from an electric motor running at 2500 r.p.m. through an intermediate shaft which runs at 9150 r.p.m. Each bearing contains 12 balls of 1/8 in. diameter. The balls are not caged. A special kind of rubber is used for the driving belts. The spindle apparently reaches its critical speed at 33,000 r.p.m., as when it attains approximately this speed the belt starts to oscillate badly; as the speed increases, however, this effect dies down and the belt again runs smoothly. This spindle is yet in the experimental stage, but it has been run hour after hour without undue heating, the period being apparently limited by belt endurance. The wheel was not cutting during these runs.

A more definite stage of practicality has been reached with the next size of spindle, which is provided with the same type of cup and cone bearings designed to run at 40,000 r.p.m. and fitted with a 1/2-in. wheel to give a surface speed of approximately 5000 ft. per min. This spindle is regularly in work at the maker's plant and is said to have been operated at 37,312 r.p.m. grinding out hardened steel gears, with a band of rubber that had stood for three working days without stretching or warping. This spindle has been tested by the National Physical Laboratory up to a speed of 45,460 r.p.m.

The University of Wisconsin has established a Bureau of Commercial and Industrial Relations which will provide information or service in this field. A series of bulletins treating with the following subjects are in process of issue at monthly intervals.

- A Labor Policy and The Labor Audit
- Job Analysis
- The Cycle of Employment
- Industrial Housing
- Government in Industry
- Underemployment and Absenteeism
- Wages and Earnings
- Insurance and Pensions
- Industrial Training and Vocational Guidance
- Industrial Housekeeping
- Plant Newspaper
- Industrial Safety and Hygiene.

In addition to the above circulars a Bibliography Service will be developed. Arrangements are being made to carry forward special Research Service and to make the results available to those interested. A plan is being worked out whereby advanced students may be detailed to special projects in industrial units, working under the close supervision of the Industrial Relations Bureau.

An Analysis of Machined Fits

A.E.S.C. Sectional Committee Acting Through One of Its Sub-Committees Presents a Comprehensive Questionnaire to American Industry

THE July 1920 issue of MECHANICAL ENGINEERING announced the organization and the personnel of the Sectional Committee on Plain Limit Gages for General Engineering Work, a Sectional Committee which is working under the Rules of Procedure of the American Engineering Standards Committee and is sponsored by The American Society of Mechanical Engineers. After a preliminary canvass of the gaging situation carried on during the summer months, the Committee subdivided itself into three working sub-committees. To these sub-committees have been assigned the three subdivisions of the subject, viz., (*a*) standards and tolerances for manufactured material; (*b*) methods of gaging manufactured material; and (*c*) gages and their limits, manufacture, and use.

The Sub-Committee on Standards and Tolerances for Manufactured Material, to which has been assigned the task of preparing a set of standard allowances and tolerances for mating parts in interchangeable manufacture, has after considerable discussion and consultation with manufacturers prepared a questionnaire, full and complete, answers to which it earnestly requests. Since by the method of its organization the report of the full Committee when approved by the A.E.S.C. will establish American standard practice, it is very desirable that everyone interested in any way in this set of standards should know of this activity and should have a part in it, if he so desires. MECHANICAL ENGINEERING therefore takes pleasure in reprinting this questionnaire in full and invites its readers to send their replies addressed to the Committee, care of The American Society of Mechanical Engineers, 29 West 39th Street, New York City.

QUESTIONNAIRE

For the purpose of clearness and after very careful consideration, the Committee has subdivided all machined fits into four classes. These are listed below with the kinds of work which seem to fall in each class.

CLASS No. 1 LOOSE FITS

Machined fits of agricultural, domestic, and other machinery of similar grade (wagons excepted)
Mining machinery
Controlling apparatus for marine work, etc.
Textile and rubber machinery, candy and bread machinery and others of similar grade
Some parts of ordnance
General machinery for manufacturing.

Question 1. What allowances do you make in this class?

CLASS No. 2 MEDIUM FITS (Moving Parts)

2 *a* High Speeds (over 600 r.p.m) and Heavy Pressures

Electrical machinery
High-speed parts of woodworking machines
Sewing machines
Machine tools
Locomotives
Printing machinery
Automotive
Ordnance
General machinery for manufacturing.

A well-known firm uses allowances of 0.0005–0.004 in. up to 6 in. for work of this class.

Question 2. How does this compare with your practice?

CLASS No. 2 MEDIUM FITS

2 *b* Ordinary Speeds (under 600 r.p.m.) and Light Pressures

Machine tools
Printing presses and machinery
Typewriters, calculating machines, etc.
Locomotives
Automotive—general parts
Textiles, rubber machinery
Ordnance
General machinery for manufacturing.

A well-known firm uses allowance of 0.0005–0.0025 in. up to 6 in. for work of this class.

Question 3. How does this compare with your practice?

CLASS No. 3 SNUG FITS

(Designated as the closest fit that can be assembled by hand.)

3 *a* *Slight Allowance* (0.00025 to 0.00075 in.)

Gear trains and change gears for general work
Mating parts, fixed or not, moving on each other, such as studs for gears and levers, keys
General machinery for manufacturing.

Question 4. Do these allowances agree with your practice?

3 *b* *Close Fit* (commonly known as wringing fit, no allowance, not considered interchangeable manufacturing but selective assembling)

Crankshafts
Precision-ground machine spindles
Gears in index train of precision gear-cutting machines
Slots and tongues such as are used for grinding machines, milling machines, etc.
Surveying and scientific dental instruments, etc
General machines for manufacturing.

Question 5. Should no allowance be made in machining the fits in this class?

CLASS No. 4 TIGHT FITS

4 *a* *Drive Fits* for Light Sections

Automotive
Ordnance
General machines for manufacturing.

A well-known firm uses negative allowance from 0.00025 to 0.001 in. up to 6 in.

Question 6. How does this compare with your practice?

4 *b* *Force Fits* for Heavy Sections

Locomotive and car wheels
Crank disks, armatures, flywheels
Automotive
Ordnance
General machines for manufacturing.

A well-known firm uses negative allowance from 0.00075 to 0.005 in. up to 6 in.

Question 7. How does this compare with your practice?

4 *c* *Shrink Fits*

Locomotive tires and similar work
Ordnance.

A well-known concern's practice is as follows: Where thickness exceeds 3/8 in., 0.0005 to 0.005 in. up to 6 in. in diameter. Where thickness is less than 3/8 in., up to 6 in. in diameter, 0.00025 in. to 0.0015 in

Question 8. How does this practice compare with yours?

The Committee would greatly appreciate having your full answers also to the three following general questions with as much explanatory information as possible:

Question 9. How many of the four kinds of fits previously mentioned apply to your work?

Question 10. Will you send the Committee blueprints or other data showing your practice in as many of these cases as possible?

Question 11. How do you specify both allowance and tolerance for mating parts—such as a solid 2-in. bearing and the shaft which runs into it?

The following sketches show some of the problems. Will you kindly give the Committee as much information as possible regarding your practice in such cases.

Question 12. What allowance and what tolerance would you give on such a piece as shown in Fig. 1: (*a*) for a milling-cutter arbor, (*b*) for a work-holding mandrel?

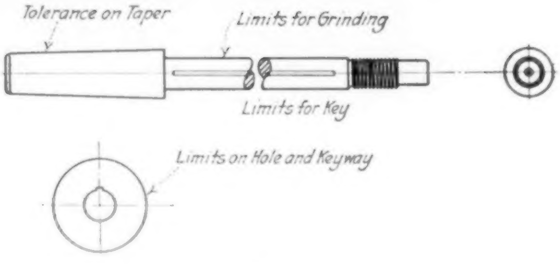


Fig. 1

Question 13. What allowance and what tolerance would you give on the keys and keyways shown in Fig. 2, where
(*a*) Keys are tight in both shaft and hub;
(*b*) Keys are tight in shaft—sliding in hub;
(*c*) Keys are tight in hub—sliding in shaft?

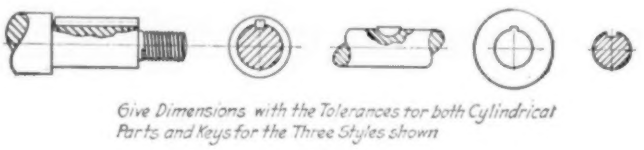


Fig. 2

Question 14. What difference in allowances and tolerances would you give on the bearing and gear fit shown in Fig. 3?

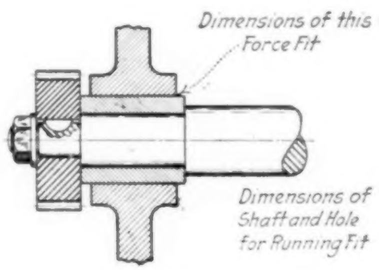


Fig. 3

The fit of a wrench is shown in Fig. 4.

Question 15. What is your practice as to allowance and tolerance for maximum looseness and maximum tightness?

Fig. 4

The rocker arm shown in Fig. 5 contains several kinds of fits.

Question 16. What allowance and tolerance would you give at *A*, *B*, and *C*?

Two shrink fits are shown in Figs. 6 and 7, one a thin shell, the other a locomotive tire. The latter also has a press fit.

Question 17. What is your practice on work of this or a similar character?

In multiplying movements the lost motion often plays an important part.

Question 18. What is your practice in such cases as shown in Fig. 8—for both allowance and tolerance?

Fig. 9 shows a light sliding fit for accurate grinding or similar work. Fig. 10 illustrates a working slide fit for turret slide or for similar purposes.

Question 19. What are your allowances and tolerances in such cases?

Question 20. Do they vary with the length of the slide?

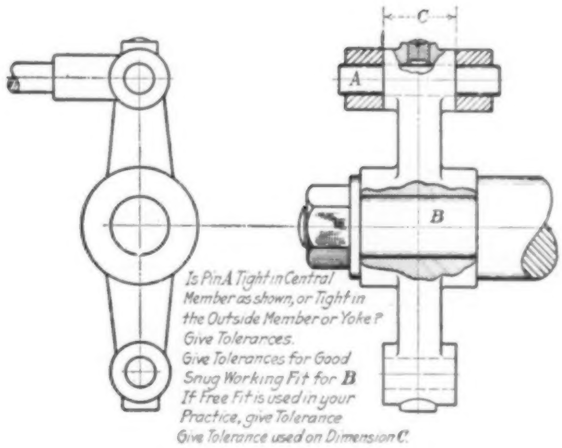


Fig. 5

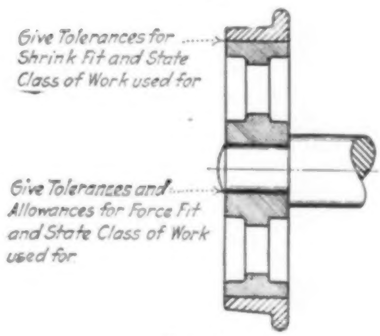


Fig. 6

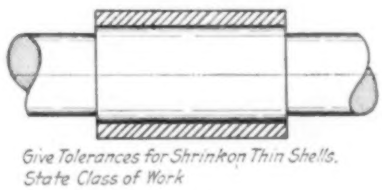


Fig. 7

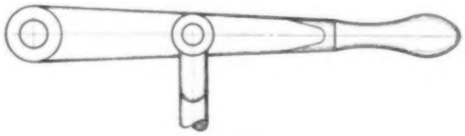


Fig. 8

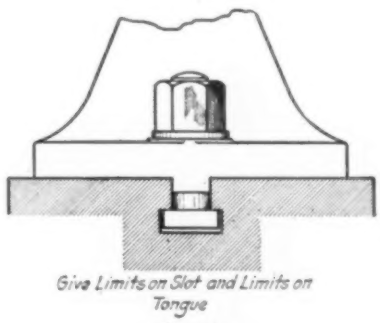


Fig. 9

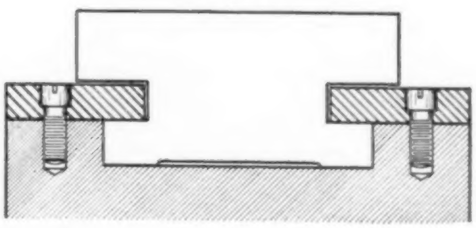


Fig. 10

(*Continued on page 144*)

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Committee Notes

THE Special Committee on the Strains due to the Vibration of Shafting will probably organize during the present month under the chairmanship of Mr. N. W. Akimoff. The work of this committee is most important owing to the fact that within recent years a number of failures of the main shafts of vessels have failed from this cause. The committee plans to collect the present knowledge on this subject and then to complete the work as far as possible for the use of the engineering profession.

The Committee on the Present State of the Knowledge Regarding Riveted Joints, under the chairmanship of Dr. A. D. Risteen, will also begin work soon. It is not expected that these two committees will report within two years on account of the amount of work to be done.

The Research Committee plans to use the library of the United Engineering Society and any other collection of data for the work of these committees, and would welcome suggestions from members of the Society regarding problems which demand investigation.

The Scovill Bulletin

The Scovill Manufacturing Company, Waterbury, Conn., has issued as a supplement to the Scovill Manufacturing Company Bulletin, a pamphlet of fifteen pages giving a short description with a photograph of its chemistry and test building, and a paper on the application of metallurgy to the brass industry. The paper includes halftones showing the peculiar nature of alloyed metals and the effects of improper handling during the course of manufacture. The effect of annealing, of continued heating at high temperatures, of improper casting practice, of improper annealing, of improper manufacturing methods and the results of experimental annealing are illustrated in the halftones. The pamphlet also contains halftones showing part of the equipment of the laboratory and explains how the microscope can be an aid in the manufacturing department. Mention is made of the diseases of metals, also of casting, shop problems and the selection of the proper metal for particular pieces of work.

Report of British Inquiry Committee on Lubricants and Lubrication

The Report of the Inquiry Committee on Lubricants and Lubrication has now been published for the Department of Scientific and Industrial Research by H. M. Stationery Office.

The Committee was set up as the outcome of an application made to the Advisory Council for a grant in aid of proposed researches to determine the relation between the viscosity of lubricants and the load on a bearing, and the action of lubricants at high temperatures as applied to commercial methods of oil testing. The Advisory Council deprecated an attempt to obtain partial results in any section of the field for research in lubrication and recommended that an Inquiry Committee be set up under the Department to prepare a memorandum on the field for research, containing an analysis of the problems involved together with a suggested scheme of research which would be likely to lead to valuable results.

The Report of the Committee under these terms of reference is now published and is divided into the following sections:

1 Introductory
2 Bibliography
3 Research work instituted by the Committee
4 Bulletins
5 Existing knowledge of lubrication
6 Review of existing knowledge
7 Recommendation for future research on Lubricants and Lubrication
8 Liaison with the American Bureau of Standards
9 Conclusion.

Subjoined to the Report are 20 appendices by various authors which contain particulars of a number of researches instituted by the Committee on certain fundamental problems on which knowledge was lacking.

Copies of the report (price 2s.6d., by post 2s.8½d.) may be obtained through any bookseller or directly from H. M. Stationery Office at the following addresses: Imperial House, Kingsway, London, W. C. 2, and 28 Abingdon St., London, S. W. 1; 37 Peter St., Manchester; 1 St. Andrew's Crescent, Cardiff; 23 Forth St., Edinburgh; or from E. Ponsonby, Ltd., 116 Grafton St., Dublin.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A2-21. ARTIFICIAL SEASONING OF GAGE STEELS. An investigation has been made by the Bureau of Standards on various seasoning treatments on the permanence of gage steels. Various hardened gages were heated in oil at different temperatures under varying time conditions and subject to seasoning by dipping in hot oil and iced brine. Short gages of ⅛ in. showed no appreciable change in length with or without various artificial seasoning treatments over a period of seven months beginning one or two weeks after hardening. Length gages of 2 in. showed no appreciable change in planeness. For studying length change it has been shown that lengths from 6 in. to 8 in. are desirable.

Duplicate gages show wide variations in length change. One block showed no dimensional change in 217 days between first and last measurement, while a duplicate decreased 0.00018 in. in the same period. On account of softness, stainless steel is unsatisfactory. Higher-carbon alloys of this type would be more desirable, with a possible decrease in chromium which would not impair the stainless qualities and at the same time reduce the production cost. Plain carbon steel of 1.18 per cent carbon appears least desirable from the standpoint of permanence. The most desirable steels are HC and K, subject to different seasoning treatments. Measurements at intervals of one week, 1, 2, 4, and 7 months after initial measurements of length and planeness do not give very much information regarding the progress of the changes taking place. Where great changes occur they appear to progressively increase with time. Many changes occur immediately following the first measurements. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials B2-21. REINFORCED-CONCRETE SLABS. The Cement Gun Company, Inc., of Allentown, Pa., has issued a pamphlet of thirty-two pages on the Strength of Gunite Slabs. The formula used for these slabs has been checked under the supervision of Prof. M. O. Fuller, of Lehigh University, by a number of tests of slabs of 4-ft. span, 6-ft. span and 8-ft. span. The pamphlet contains data for balance percentage of reinforcement, safe loads for gunite slabs with a factor of safety of 4 with 1:3 mix and 1:2½ mix, and safe live loads for factor of safety of 5 with a 1:3 mix. The tables give the thickness of the slabs and the area of reinforcement per foot of width of slab. The pamphlet contains an analysis of the data by George F. Strehan and the report of Professor Fuller with tables containing the data obtained on the tests from the slabs, the cement and the sand used, as well as curves giving the results of the tests and photographs showing the method of testing. Address Cement Gun Company, Allentown, Pa.

Cement and Other Building Materials B3-21. FLOOR TREATMENT. The Bureau of Standards has issued a report on the service tests of various floor treatments carried out by the Bureau. The first materials were applied to the floors of the Northwest Building of the Bureau of Standards five months after its completion in March 1918. The sections were panels 8 ft. square and extending the width of the corridor and

8 ft. along its length. The traffic on all sections is similar. The materials used were as follows: Vitrograin, Flintox, Acid Proof Filler, Cement Filler, Lapidolith, Crystalrox, Saniseal, Colorseal, Magnesium Fluosilicate, Indurite, Liquid Concrex, Esco, Bilchaco, Concreto, Minwax, Thermowax and Saum's Preservative, produced by different manufacturers, and simple materials made at the Bureau of Standards such as sodium silicate, aluminum sulphate, linseed oil, fuel oil and soap and soap treatment.

The results of the home-made solutions are given below from A to J and U and V, while the other results are from the manufactured materials mentioned above under their trade names.

A. A treatment of 15 per cent solution of magnesium fluosilicate applied in three coats gave a surface which was quite hard after two years and three months of service with no wear showing except for a few small areas. The first coat was one part solution and two parts water; the second coat was one part solution and one part water; the third coat was two parts solution and one part water.

B. An 8.7 per cent solution of magnesium fluosilicate applied in three similar coats has been in use for one year and nine months. This shows considerable wear.

C. A $14^1/_2$ per cent solution of magnesium fluosilicate applied once in a heavy coat has been used for two years and two months and appears to be in a good condition. No wear is apparent.

D. A treatment of $11^1/_2$ per cent solution of magnesium fluosilicate in three coats shows no definite signs of wear after one year and eight months.

E. An 18 per cent solution of magnesium fluosilicate with a small amount of zinc fluosilicate applied in three coats gives no appreciable wear after two years of service.

F. A solution of 7.3 per cent magnesium fluosilicate with 2.6 per cent magnesium sulphate and $4^1/_2$ per cent of free hydro fluosilicate is unsatisfactory.

G. A 16 per cent solution of zinc sulphate with about $4^1/_2$ per cent of free sulphuric acid applied without dilution in two coats has given excellent satisfaction after two years and three months of service. After the first application had dried for four hours the surface was scrubbed with hot water and mopped dry before the application of the second coat. This gave a darker appearance to the original concrete.

H. A 20 per cent solution of sodium silicate containing small addition of organic acid applied without dilution in two coats 24 hr. apart gave excellent results after two years and two months of service. This treatment gave a brighter and more uniform appearance than the original concrete.

I. A treatment of 8 per cent solution of commercial sodium silicate in three coats if preceded by a thorough scrubbing with water gives excellent service after two years and two months. The treatment gives a hard surface of uniform appearance which is lighter in color than the original.

J. A 15 per cent solution of aluminum sulphate applied in three diluted coats gave satisfactory results after one year and six months of service. The surface is not so hard as that obtained by other treatments, but it is effective in holding dust. It is applied without interfering with traffic. The first coat was one part solution to two parts water, the second coat was one part water to one part solution and the third coat was two parts solution to one part water.

K. Gray paint of proprietary make containing lead sulphate, siliceous matter and carbon in varnish vehicle is showing the effects of wear after two years and two months service.

L. A china wood-oil varnish applied in two coats 24 hr. apart has been in service two years and one month with few scratches due to moving machinery. It is wearing thin in places.

M. China wood-oil varnish in two coats applied two years and two months show no appreciable wear.

N. Boiled mineral spirits varnish applied in two coats at intervals of 24 hr. in service two years and one month is worn in places.

O. Gray paint with pigment of basic lead sulphate, zinc oxide, barium sulphate, siliceous matter and carbon in linseed oil, rosin vehicle thinned with mineral spirits, applied in two coats, shows no signs of wear except scratches from machinery after one year and five months. Waxlike finish but not especially resistant to scratching, although under foot traffic.

P. Thick paint of zinc oxide, lithopone and bone black in varnish vehicle containing rosin. Only one coat was used but the directions require two coats. After one year and six months large scratches from machinery were noted. Thick film gives a surface pleasing to walk upon. Small spots have blistered and worn away.

Q. A solution of heavy carbon wax in light carbon oil applied in two coats. After two years and three months it was considerably worn. Object of this treatment is to hold dust and not to harden surface.

R. Treatment of mixture of waxes applied in molten condition worn through under office chairs. Considerable wear after two years and four months.

S. Linseed oil with small addition of citronella applied in first coat and kept dry. Test does not show true value of treatment.

T. Four applications of raw linseed oil thinned with turpentine. Service two years and two months. Results at first not satisfactory but surface hardens gradually and at present is quite hard. It appears to resist the wear very well.

U. Examination of slab subject to frequent scrubbings with thick soap solution. No polished condition results from this under wear.

V. Treatment of emulsion of fuel oil and soap of three quarts of oil, two bars of ivory soap and four gallons of water. Emulsion applied with a mop at intervals of one or two weeks. After 10 applications floors are greatly improved and do not dust. Surface is somewhat harder than original. Application leaves floors slippery for a few hours.

Conclusions:

1 Materials of the magnesium fluosilicate class gave very good results although more knowledge is needed concerning proper strength of solution.

2 Zinc sulphate treatment gives excellent results.

3 Surface-coating materials are most effective in entirely eliminating dust.

4 Home treatments I and J prove very successful and quite inexpensive. The following directions are given:

A—Sodium Silicate Treatment

Commercial sodium silicate usually varies in strength from 30 to 40 per cent solution. It is quite viscous and has to be thinned with water before it will penetrate the floor. In ordinary cases it will be found satisfactory to dilute each gallon of the silicate with four gallons of water. The resulting five gallons may be expected to cover 1000 sq. ft. of floor surface one coat. However, the porosity of floors varies greatly and the above statement is given as an approximate value for estimating purposes.

The floor surface should be prepared for the treatment by cleaning free from grease, spots, plaster, etc., and then thoroughly scrubbed with clear water. To get the best penetration the floor should be thoroughly dry, especially before the first application, and if practical it is well to let it dry for several days after the first scrubbing. The solution should be made up immediately before using.

It may be applied with a mop or hair broom and should be continuously brushed over the surface for several minutes to obtain an even penetration. An interval of 24 hr. should be allowed for the treatment to harden, after which the surface is scrubbed with clear water and allowed to dry for the second application. Three applications made in this manner will usually suffice, but if the floor does not appear to be saturated by the third application a fourth should be applied.

This treatment when properly applied gives a very hard surface that is bright and uniform in appearance. The commercial sodium silicate can be obtained from wholesale druggists usually at a cost of 40 cents or less per gallon.

B—Aluminum Sulphate Treatment

The solution of aluminum sulphate for this treatment should be made in a wooden barrel or stoneware vessel. The amount required may be estimated on the basis of one gallon of solution for each 100 sq. ft. of area. For each gallon of water $2^1/_2$ lb. of the powdered sulphate will be required. The water should be acidulated with commercial sulphuric acid by adding 2 cc. of the acid for each gallon. The sulphate does not dissolve readily and has to be stirred occasionally for a period of a few days, until the solution is complete.

The floor should be cleaned of grease spots, plaster, etc., then thoroughly scrubbed. When the surface is entirely dry, a portion of the sulphate solution may be diluted with twice its volume of water and applied with a mop or hair broom. After 24 hr. dilute a portion of the original solution with equal volume of water and apply in the same manner as the first. Allow another interval of 24 hr. and make an application using two parts of the sulphate solution to one part of water. Each application should be continually brushed over the surface for several minutes to secure a uniform penetration. After the third application has dried, the surface should be scrubbed with hot water. This treatment will give good results at a cost about equal to that of the sodium silicate treatment. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Chemical, General and Physical A1-21. Inflammability of Jets of Hydrogen and Inert Gas. An article by P. G. Ledig, *Journal of Industrial and Engineering Chemistry*, vol. 12, page 1098, gives the following:

Under favorable conditions a jet of helium containing more than 14 per cent of hydrogen can be ignited in the air.

Eighteen to twenty per cent of hydrogen may be mixed with helium without producing a mixture which will burn with a persistent flame when issuing from an orifice under the conditions prevailing in balloon practice.

More than twenty per cent of hydrogen can not be used in balloon practice without sacrificing safety from fire. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Light A1-21. Personal Error in Using Parallel Cross-Hairs in Micrometer Microscope. The Bureau of Standards has recently made observations on the diameter of wire employed in certain sieves, using a micrometer microscope setting two parallel cross-hairs so that the edge of the wire was midway between them. Five observers were used. The results showed an evident personal error, confirming the metrological principle that it is difficult to match an equal width of bright and dark space. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A3-21. Decarburization of Steel by Heating in Vacuo. Steel specimens heated for 24 hr. at approximately 760 deg. cent. had carbon content reduced from 0.54 per cent to 0.36 per cent. Material was an iron-carbon alloy prepared at the Bureau of Standards to which no addition other than carbon had been made. An explanation for this action assumes the presence of

oxygen in some form, as commercially prepared steel which has been deoxidized in manufacture behaves very differently from the small melts made at the Bureau. This investigation is being continued. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A4-21. MAGNESIA FOR CRUCIBLES USED WITH ELECTROLYTIC IRON AND IRON-CARBON ALLOYS. The Bureau of Standards has prepared 100 lb. of electrolytically fused magnesia which contains less than 0.02 per cent SiO_2. This is not large enough to prevent the use of magnesia in melting electrolytic iron and iron-carbon alloys. Crucibles of fused MgO undergo so little shrinkage that it is possible to melt in the tamped and dried crucible without the preliminary calcination to 1500 or 1600 deg. cent. which was necessary with the old type of crucible. Samples of zircon have been obtained to compare with zirkite. These two zirconium refractories are at present obtainable commercially. The preliminary tests showed that refined zircon has a melting point considerable below zirkite cement. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A5-21. GRAIN SIZE AND BRINELL HARDNESS OF CARBON STEEL. A paper on relation of grain size to Brinell hardness of annealed carbon steel by Rawdon and Jimeno has appeared in printed form and is ready for distribution. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A6-21. ARC-FUSED STEEL. *Chemical and Metallurgical Engineering* for Oct. 20, 1920, contains the second installment of results of an investigation on the metallography of arc-fused steel conducted at the Bureau of Standards. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Metallurgy and Metallography B2-21. HEAT TREATMENT OF CARBON STEEL. The Committee on Heat Treatment of Carbon Steel of the Division of Engineering, National Research Council, is continuing its work on this subject. Many tensile test pieces and impact test pieces have been used. Materials used have been investigated for magnetic properties and all materials have had the preliminary heat treatment. The heat treatment of the specimens has been accomplished in a special furnace and care has been exercised to determine the temperature of treatment very accurately. Address Dr. Henry M. Howe, Chairman of Committee, 29 West 39th St., New York.

Metallurgy and Metallography B3-21. FATIGUE OF MATERIALS. The joint investigation on the fatigue of materials under the direction of Prof. H. F. Moore is progressing at the University of Illinois. Already many tests have been run, and although no conclusions can be definitely drawn from the results at present, certain indications have been obtained. Address Prof. H. F. Moore, University of Illinois, Urbana, Ill.

Metallurgy and Metallography B4-21. SUBSTITUTE DEOXIDIZERS. The manufacture and testing of new deoxidizing alloys described in a paper by J. R. Cain for the Division of Engineering of the National Research Council is in progress. Five of the alloys have been made at the Bureau of Standards and five other by the Metal & Thermit Corporation, while the Fitzgerald Laboratories are to make others. The lead-magnesium alloy had had a preliminary test at the Bureau of Standards for deoxidizing American ingot iron. All of the alloys are to be tested at the Bureau of Standards for deoxidizing efficiency. Address J. R. Cain, Bureau of Standards, Washington, D. C.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Metallurgy and Metallography C1-21. ABSORPTION IN FURNACES. An inquiry has been received by the Research Committee regarding the absorption of heat by steel. The statement was made that steel absorbs heat as the 6th power of the radiancy and that this absorption does not mean the radiation of heat by the Stefan-Boltzmann Law. The Research Committee is not able to explain this statement and would appreciate any communication with the inquirer regarding the meaning of the above statement and the reference to an authority regarding it. Address A. E. Walden, 100 West Fayette St., Baltimore, Md.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Victor J. Azbe, D1-21. POWER-PLANT LABORATORY. Laboratory equipped with apparatus for chemical analysis and physical tests concerning power-plant economy. Fuels of all kinds, solid, liquid and gaseous, are handled. Apparatus for making determinations of the fusing point of ash, for water testing and analysis of boiler scale are included. General industrial work is to be cared for by the laboratory. Address Victor J. Azbe, 2194 Railway Exchange, St. Louis, Mo.

Scovill Manufacturing Company, D1-21. THE SCOVILL MANUFACTURING COMPANY, of Waterbury, Conn., has a separate building 213 ft. long, 50 ft. wide and 20 ft. high devoted to research work and control work for its product. The building is subdivided into offices, library and rooms for metallography, electric-furnace work, photography, polishing, weighing, physical testing and a main laboratory for routine work in analysis of brass, bronze, nickel, silver, cupronickel, steel, copper, spelter, special alloys and oils and greases. During the war there were 94 people employed in the laboratory. Address Scovill Manufacturing Company, Waterbury, Conn.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

Victor J. Azbe, E1-21. Mr. Azbe, who has been devoting many years to the investigation of losses in steam-power development, has realized the importance of supplementing his field work with the equipment of a research laboratory for prompt and accurate reports on materials used in power plants. For this purpose he has established a laboratory for carrying out chemical analysis and physical tests. This laboratory will be devoted to reports on materials for general industrial work. Address Victor J. Azbe, 2194 Railway Exchange St., St. Louis, Mo.

Materials of Engineering E1-21. STANDARD SAMPLES. The Bureau of Standards is distributing standard samples of materials for comparison and other uses such as control analysis. During the month of November 434 samples were issued costing \$849.25. Sample 23-A of Bessemer 0.8 per cent carbon steel and No. 51 electric-furnace 1.2 per cent carbon steel were issued for the first time. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

Petroleum, Asphalt and Wood Products, F1-21. RECENT ARTICLES ON PETROLEUM. The recent articles on petroleum and allied substances are compiled each month for the Bureau of Mines by E. H. Burroughs. This bibliography includes articles on geology and the origin of petroleum, on development and production, patents, transportation, storage and distribution, properties and their determinations, refining and refineries, utilization, legislation and legal regulation, statistics, economics, organization and institutions. It also gives a list of bibliographies on this subject. Address Bureau of Mines, Washington, D. C., H. Bain Foster, Director.

Bibliographies Compiled by U.E.S. Library

The Engineering Societies Library announces the completion of bibliographies covering the subjects ofP ulverized Coal and Fuel Oil for Raising Steam. The former contains 41 typewritten pages and has 283 references, each accompanied by a short explanatory note. It covers the years from 1910 to 1920. The latter, extending over the years 1911 to 1920, covers 22 typewritten pages and contains 201 references. The search is divided into five parts: (1) General; (2) coal vs. oil; (3) marine use of oil; (4) oil for locomotives and (5) apparatus and combustion.

Those desiring to purchase copies of these bibliographies should address Mr. Harrison W. Craver, Director of the Engineering Societies Library, 29 West 39th Street, New York, N. Y.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Objects to the Use of Greek Symbols

TO THE EDITOR:

I wish to make a criticism of the use of Greek letters in the columns of MECHANICAL ENGINEERING.

My attention has been called to a paper in your November issue, entitled Calibration of Nozzles for Measurement of Air, etc., where repeated use is made of the symbol "psi" for an important coefficient. The objection to a Greek letter in this connection is that the language has been dropped from the educational system. Engineers do not study Greek, and probably few of them know more than three letters of the Greek alphabet.

Greek symbols are therefore unfamiliar to a majority of your readers. Their further use in your columns is hardly defensible except on grounds of tradition and precedent. No reader likes contact with a symbol which he does not know how to pronounce, and which he hesitates to write. The printer must find Greek a nuisance to set up. Those of us who use typewriters find it troublesome, because Greek is not on the keyboard.

I am aware of the fact that engineering literature is full of Greek letters and that certain symbols such as "pi," ratio of circumference to diameter, and "delta," symbol of differentiation, will survive. My plea is that in original papers, offered to engineers through your columns, the use of Greek letters be discouraged, if not definitely forbidden.

E. H. LOCKWOOD.

New Haven, Conn.

Books for Supplementary Reading by Students

TO THE EDITOR:

Supplementing my communication in the January number asking for suggestions of books for supplementary reading by students in industrial management, I append a list which we have used for the course at the University of Illinois.

The objects of this supplementary reading are several, namely: To broaden knowledge of the principles underlying the conduct of industrial affairs; to promote a better understanding of the human element and its relation to industry; to enlarge acquaintance with the ideals and methods of distinguished thinkers, investigators, and producers; and to develop clearer conceptions of the tasks which engineers entering the industrial world are called upon to perform.

Four books are to be read and reported from the following list:

- Principles of Management, by Taylor
- Twelve Principles of Efficiency, by Emerson
- Work, Wages, and Profits, by Gantt
- Investigating an Industry, by Kent
- Human Factor in Works Management, by Hartness
- New Industrial Day, by Redfield
- Organizing for Work, by Gantt
- Industrial Goodwill, by Commons
- Motion Study, by Gilbreth.

Books are assigned arbitrarily unless the student already has read certain volumes or when personal preference for particular authors is supported by satisfactory reasons. In the case of students who desire to do additional reading, assignments are made from a subsidiary list of books as follows:

Man to Man, by Leitch; Work and Wealth, by Hobson; Psychology and Industrial Efficiency, by Münsterberg; Time Studies and Rate Setting, by Merrick; Fatigue and Efficiency, by Goldmark; Scientific Management and Labor, by Hoxie; Turnover of Factory Labor, by Slichter; Common Sense and Labor, by Crowther; Personnel Administration, by Tead and Metcalf; Principles of Industrial Organization, by Kimball; Profit-Making Management, by Carpenter.

The reading of books relating to practical application of methods or descriptive of existing systems of management is discouraged at this time, but a complete bibliography of management is supplied and suggestions offered as to the many admirable books which should be helpful in actual practice. It is believed that during this period attention should be focused almost exclusively upon principles rather than upon the details of practice and the selection of books is made with this consideration in view.

This matter is presented here in this form to stimulate interest in the general topic of reading, not only for the younger generation of engineers, but also for all engaged in the profession. What books should be read by young men in training for careers in the industrial or engineering world? What substitutions, withdrawals, or additions in titles can be made with profit in the lists of books referred to previously? Is there a "Three-Foot Shelf of Books" for engineers? These are questions of rather large significance and in my opinion a discussion of them in the columns of MECHANICAL ENGINEERING will confer direct benefits on a large section of the membership of the Society. May we not have such a discussion?

BRUCE W. BENEDICT.

Urbana, Ill.

Extending Ocean Navigation to the Great Lakes

TO THE EDITOR:

Replying to the communication of Charles Whiting Baker on page 592 of MECHANICAL ENGINEERING for October, concerning the development of the St. Lawrence River as a waterway, I wish to call your attention to some important considerations that have been neglected.

The City of Chicago, one of the most southerly of Great Lakes ports, is closed to navigation by ice for at least five months of the year. Furthermore, the other end of the proposed waterway, the mouth of the St. Lawrence River, is 625 miles north of Chicago. The region of the ocean north of Sable Island and the Banks of Newfoundland, between Cape Sable and Sable Island, in close proximity to the Strait of Belle Isle, is known to all deep-water sailors as the "Graveyard of the Atlantic." The navigation of this region is regarded by all ship owners and underwriters as the most hazardous of the entire globe, owing to the quantities of ice from the coast of Labrador, much of which is forced through the Strait of Belle Isle, involving the Gulf of St. Lawrence in an almost constant menace of snow, ice and fog to all shipping entering or departing from the Gulf and its neighboring waters. The Allan Line of English ships operates from Montreal under a heavy subsidy or contract with the British Government and every winter it is obliged to abandon its regular St. Lawrence route and port of call for some port on the coast further south.

In view of the conditions of navigation above submitted, and of the complete failure of the former attempts to overcome the difficulties, it is respectfully submitted that the theories of Charles Whiting Baker and Mr. Merrick, President of the Association of the Chamber of Commerce of the City of Chicago, together with the visions of great commercial development throughout the fourteen states in proximity to the Great Lakes, as the result of these theories, are based upon misleading and fallacious arguments, resulting from a complete lack of knowledge of conditions as already experienced, and involve the expenditure of millions of dollars in a venture which is foredoomed as a successful financial enterprise.

Garden City, N. Y. E. PLATT STRATTON.

Sees Danger in St. Lawrence River Project

To the Editor:

The St. Lawrence project is being discussed. This project contemplates the construction of canals, locks and dams whereby to provide a navigable water passage from the Great Lakes to the Atlantic Ocean. That this project will be of value to the United States need not be gainsaid.

It is true that the products and manufactures of the Middle West can be shipped through the lakes and St. Lawrence River and its proposed canals to the ocean for domestic and foreign ports at far less expense than they can now be shipped when they must be transferred from lake boats to rail and then, for foreign commerce, again to boats. It is true that practically all of the commerce of the Middle West would pass through this canal; and the Middle West is our great industrial center. It is said that the railroads would be injured by the diversion of freight traffic; but the railroads would make provision for this loss and their spare rolling stock, if any, would be diverted to other regions in sufficient numbers to permit the operation of the remaining equipment at full capacity.

In the St. Lawrence project, however, resides a grave danger to the economic and political welfare of the country; and this project should not be carried to completion.

The mouth of the St. Lawrence River lies entirely within the boundaries of a foreign country and is comparatively remote from the boundaries of the United States. If the project be carried out, the business of the entire Western and New England States and the political welfare of the whole country at large will be dependent upon the maintenance and continuance of friendly relations with our neighbor. While we have the greatest friendship and respect for that country and hope that serious differences will never arise between us, yet it is not without the bounds of reason, and also of experience, to anticipate serious differences; and, if ever a state of war does spring up, the mere blockade of the mouth of the St. Lawrence River will utterly cripple the entire industrial section of our country. Our railroads will immediately become so congested by the attempted diversion of the water freight to rail as to be useless by reason of the previous reduction of their rolling equipment. No one can predict, in these troublesome times, a continuance of peace. It must be remembered that the country controlling the outlet of the St. Lawrence is but one of the children of that mother country across the sea. That mother country, by virtue of possession of Gibralter at one end and the Suez Canal at the other end, governs traffic in the Mediterranean Sea; and by possession of the Dardanelles controls the economic condition of lower Russia. By diverting the traffic of the industrial section of the United States through the St. Lawrence River, that mother country would control the political and economical welfare, in time of stress, of the United States.

This project must be dropped.

T. T. Greenwood.

Boston, Mass.

Theoretical Consideration of Bending in Shafts

To the Editor:

I have never seen any literature on the subject of bending in shafts in which any attempt is made to consider the pressure distribution of the loads and reactions and the effect various distributions might have. The following was written as the result of a problem presented to me by the engineers of an industrial firm, substantially as stated. The solution with the assumptions made is very simple, and while there may be some published work covering the subject, if has not come to my attention.

So far as the writer has been able to ascertain, the methods used in practice in the calculation of the shaft bending moments have been based on the results of experience rather than any theoretical considerations. One concern had the following method for its standard practice: The reactions were first calculated assuming that they could be considered as concentrated at the centers of the bearings. The reaction forces were then considered as uniformly distributed over areas of width equal to the diameter of the shaft such that the pressure per square inch was equal to the maximum allowable crushing strength of the bushing material. These areas were at the ends of the bearings nearest the force causing the bending and the moment arms were measured from the centers of these areas. As some of the subsequent statements show, there are cases where the general theory on which the above method of calculation is based holds true. Shafts calculated by this method did give shaft sizes which agreed more or less with the results of experience, but since there was no general justification for the theory on which it was based, it was subject to erroneous use. Another concern uses one-quarter of the length of the bearing in determining the moment arm.

The concern first mentioned has recently adopted one-third the length of the bearing as determining how much of the bearing length is to be considered in the moment arm. This adoption was based on the considerations described in following paragraphs. It was found that practically all the shafts used in their work had moment arms which included about one-third the length of the bearing so that that value was satisfactory, the variations from it being within the limits of accuracy of the computations.

The maximum bending in shafts is not only a function of the various total loads and reactions, but is also a function of the distribution of the loads and reactions along the shaft. The distribution along the shaft is practically impossible of accurate determination and is affected by several factors. The flexibility of the shaft, the lack of absolute rigidity of the bearing supports, the quality of the lubrication, oil pressure, friction, and wear of the shaft and bushing, all affect the pressure distribution.

There is a tendency of the shaft to bend in the direction in which the force acts which would cause the shaft to bear only at one end of the bushing. The bearing supports also possess some flexibility and they tend to conform in position with the deflected shaft. All bearings in which the shaft revolves are lubricated and the oil film, unless completely broken, tends to equalize the pressure distribution. The friction in the bearing does not tend to vary the pressure along the shaft as it does in a circumferential direction. Wear and flow of the bushing material are undoubtedly the most important factors in determining the pressure distribution along the bearing.

With a new bearing, the pressure at one end of the bearing will unquestionably be higher than at the other due to the deflection of the shaft. The higher pressure, will however, cause greater flow of the bushing material or greater wear at the points of lesser pressure so that the tendency is to produce or at least approach a uniform distribution of pressure along the shaft. This is particularly true in case the loading is not varying greatly. In the case of intermittent shock or impact loading it is doubtful if the bearing would wear to conform with the extra deflection of the shaft due to the extra intermittent loading, but it would probably do so if the shocks occurred with sufficient frequency.

The length of the bearing would also be a factor to consider, since, if it were sufficiently long, the time required to wear the bearing down might be more than or at least a good part of the life of the machine, so that the number of repetitions of stress at somewhere near the maximum value calculated would be relatively small, making the shaft safer than was necessary. Then, too, the deflection of the shaft would probably be sufficient to cause an opposite reaction at the other end of the long bearing which would also tend to decrease the bending in the shaft. Bearings with lengths less than twice the diameter of the shaft would not be considered as long bearings, and since practically all bearings are within this limit except for other reasons than pressure, velocity, and heat dissipation, they may be neglected in any further considerations. The other considerations seem to point to a practically uniform distribution of bearing pressure along the shaft and it is assumed to be uniform in the following considerations. This assumption makes the problem a very simple one.

First, consider a shaft in which the load causing bending is beyond the bearings as shown in the force diagram, Fig. 1. If the force causing bending is F and the bearing pressure is uniformly distributed along the shaft in the bearings, the reactions may be calculated as concentrated at the centers of the bearings. If a is the distance from the force to the center of the nearest

bearing, b the length of this bearing, and c the distance from center to center of the two bearings, then

$$R_1 = \frac{(a+c)F}{c} \quad \text{and} \quad R_2 = \frac{aF}{c}$$

With uniform distribution of bearing pressure along the shaft the shear diagram is as shown in Fig. 1, in which R is the point of zero shear. R is at a distance d from the end of the bearing nearest the force F and

$$d = \frac{bF}{R_1} = \frac{bcF}{(a+c)F} = \frac{bc}{a+c}$$

The bending at any point in the shaft is equal to the area of the shear diagram either to the right or the left of the point. Since the maximum bending occurs at the point of zero shear, the maximum bending moment is

$$\begin{aligned} M &= \left(a - \frac{b}{2}\right)F + \frac{bcF}{2(a+c)} \\ &= \left(a - \frac{b}{2} + \frac{bc}{2(a+c)}\right)F \\ &= \left[a - \frac{b}{2}\left(1 - \frac{c}{a+c}\right)F\right] \end{aligned}$$

The actual bending-moment diagram for the shaft under consideration is shown in Fig. 1. The distance y is equal to $d/2$ and the area of the rectangle having F for one side and $a + y - b/2$ for the other is equal to the area of the shear diagram to the right or left of the point R. It will be noted that at the point of maximum bending the shear is zero, so that while designers ordinarily omit it from their computations because it is generally a relatively small factor in the shaft stress, it really is a zero factor at the point of maximum bending.

In case the force F is between the bearings, its pressure distribution along the shaft becomes the primary factor in the determination of the bending in the shaft. In case the loading of the force F along the shaft is practically uniform, the same equation just developed is applicable, only in this case a becomes the distance between R_1 and F and c the distance between R_2 and F, while b becomes the length of the load distribution along the shaft.

It is evident that except in short shafts there is not much difference in the bending moments determined by the above method and by the use of the distance to the center of the reaction as the moment arm. These considerations, however, are very important in the economy of material in short shafts.

In short shafts there are generally two forces as well as two reactions causing bending in the shaft. These forces may be external to the two bearings either on opposite ends of the shaft or both on the same end, and may be one or both between the bearings and in the same or different planes. So long as the pressure distribution on the bearings along the shaft is considered uniform, the bending-moment diagrams may be determined individually and then be combined to give the resultant bending

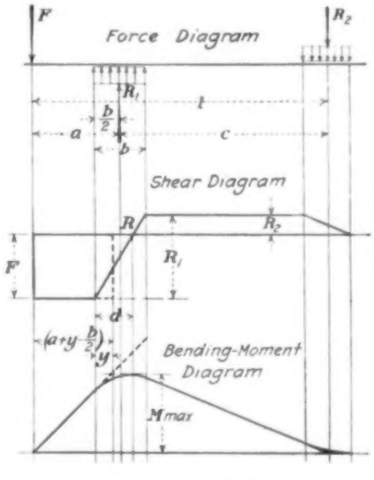


Fig. 1 Bending in Shafts

moments. The resultant points of maximum bending will probably be at some other points than the points of maximum bending for the individual forces taken alone, but will be very near them, and in the case of the two forces on opposite ends of the shaft overhanging the bearing and the case where only one force is between the bearings and the one external to the bearings is large enough to bring the maximum resultant bending in the shaft in the bearings, will not vary materially from the maximum individual moment. In the other cases, depending on the conditions of the loading, the maximum resultant bending moment may or may not differ greatly from the maximum bending moment due to one of the forces, but a trial calculation should at least be made before ignoring the other.

The foregoing method of calculation seems to offer a fairly theoretical solution which will agree quite well with practice and in some cases of design should permit of an economy of material over present methods of design. In other cases it will serve as a very good check on the safety of shafts, since any error due to the assumptions in the method is on the side of safety.

Charles W. Good.

Ann Arbor, Mich.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

Rules for the Staying of Plain Circular Furnaces

The attention of the chief boiler inspectors in the states and municipalities where the A.S.M.E. Boiler Code is effective has been called to the fact that the question of the rules for the staying of plain circular furnaces has been under consideration by the Boiler Code Committee for several months as a result of certain features that have been noted in Cases Nos. 256 and 293, in their relation to the special allowance made in Par. 212c of the Boiler Code.

A special sub-committee to the Boiler Code Committee was appointed at the October meeting of the Committee to thoroughly investigate this matter, and as a result of the discussion of the matter at the December meeting, it was decided that it would be advisable to inform them of this situation and suggest that in view of a possible revision of Par. 212c, this Rule of the Boiler Code should not be used until the Committee's investigation can be completed and reported upon.

Conference Committee on Welding

The Boiler Code Committee takes pleasure in announcing that the American Society of Refrigerating Engineers has appointed a Committee to confer with the Sub-Committee of the Boiler Code Committee on Welding. The above is the result of an invitation extended by the Council of the A.S.M.E. at the request of the Boiler Code Committee. It is the desire of the Boiler Code Committee that the Committee of the American Society of Refrigerating Engineers shall coöperate with the Sub-Committee of the Boiler Code Committee in discussing the rules now in the Code and in proposing to the Boiler Code Committee any revisions or new rules that may be embodied in the Code at the next revision period. The personnel of the Committee appointed by the American Society of Refrigerating Engineers is as follows:

Louis Doelling, *Chairman*, New York, N. Y.
E. F. Miller, Cambridge, Mass.
Fred Ophuls, New York, N. Y.
Norman M. Small, Waynesboro, Pa.
Harry Sloan, Milwaukee, Wis.

MECHANICAL ENGINEERING

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Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Motorships

Charles E. Lucke

EUROPEAN shipbuilding nations, the Scandinavians at first, but now practically all, including England, France, Holland and Italy, in addition to Germany, have for some years been building large Diesel engines and auxiliary equipment for the driving of seagoing vessels. In more recent years this movement has been accelerated by the proved economy of the equipment that has been found most reliable and the reduction in cargo-carrying costs by the motorship over the steamship. The raising of all prices and costs by the war has directed attention to every possible source of saving, and this among other things has further increased the volume of motorship building at the expense of steamship construction.

During this whole period of experimental development of the propelling machinery, and with its perfection the large-scale demonstration of lower cargo-carrying costs over competing steam equipment, America has done nothing with the motorship. On the contrary, there has been a great increase in steam cargo carriers, first as a result of war demands and later as a national movement for the reëstablishment of the American merchant marine in a position of some commanding importance at sea.

While America has been building more and more steamships, the Europeans have been building fewer in proportion, replacing them by motorships, partly on the basis of demonstrated reliability but mainly on the basis of proved reduction of operating costs. Only now have our shipping interests passed the period of consideration and entered upon that of action.

It has taken some years to convince American shipping interests that the motorship is reliable; it has taken some years to convince these same interests that America can build satisfactory engines and that they need not be reproductions of European models; but it can be said definitely that shipping interests have now reached the point of accepting this situation. It is admitted that American Diesel engines can be built equal in quality to those built in Europe and also at competing costs, but in spite of this there has not as yet been any great adoption of the motorship in this country. Only a few have been contracted for today, although a great many projects are under consideration.

Apparently American shipping interests have not yet been convinced of the superior operating economy and lower cargo-carrying costs of the motorship as compared with the steamship, especially when the latter is provided with the geared-turbine Scotch-boiler type of equipment. At the present time the future of the motorship in American shipping activities seems to be hanging in the balance of these comparative costs of operation.

The motorship equipment costs materially more to buy than does the steamship equipment. Its fuel consumption is materially less, the ratio at sea being 1 to $2^1/_2$ and still more favorable while in port. While there are corresponding differences in all of the other items of expense, such as wages and subsistence of crew, maintenance, repairs, stores, to mention a few of the leading items, it appears that the main elements of controversy and uncertainty lie in the balancing of the money saving by the motorship, due to fuel economy, against the excess of fixed charges which it must carry.

Whether or not the cheaper steamship, burning $2^1/_2$ times as much fuel as the motorship at sea, will give a lower or higher total cost of handling cargo per ton-mile, depends not only on the difference in the first costs, but also upon the prices of fuel per gallon, on the number of sea-miles per year of operation or horsepower-hours per year, or the ratio of time spent at sea to that in port; and in the case of the fuel on whether or not the motorship burns the same grade of fuel at the same price as does the steamship. For any given first-cost differential, constituting a fixed-charge handicap against the motorship, the money saving by the superior fuel economy of the motorship will be more than enough to offset it and show a net profit, provided the ship is kept at sea in actual cargo carrying a sufficiently large proportion of the total time. It will also depend on the fuel-price differential, as well as on the fuel price itself.

Analyses of these cost factors and totals indicate that the motorship is best adapted to long-distance voyages, the longer the better, and in this connection it should be noted that in the double-bottom bunkers of the motorship sufficient fuel can be carried for a total of 20,000 miles, which is much more than in the case of a steamship. The minimum length of voyage that can be profitably assigned to the motorship in competition with the steamship would seem to depend on the fuel-price differential, assuming the two ships do not burn the same grade of fuel.

As to fuel price, it seems pretty clear from what statistics are available that the general trend of price is upward, and that in view of the growth of the automotive undustry this will continue so. This being the case, so far as forecasts are at all justified, it would seem fair to predict that, if anything, conditions in the future will favor the motorship more than in the past, because with a given saving in fuel per ton-mile by the motorship over the steamship, the money saved will be greater the higher the price of fuel.

The matter of price differential, however, is a disturbing factor. The Diesel engine has in the past consistently used a higher grade of fuel oil than has been burned under the boilers of the steamship and at prices ranging from 25 cents to 50 cents a barrel more than the steamer bunker oil. Due to the increase in the demand for light petroleum products for motor cars and similar uses, there is almost sure to be a greater differential in price between the lighter fuel that the motorship has been using and the low-grade steamer bunker oil than has been the case in the past. This would be serious, and the saving in the motorship would be wiped out if the differential were great enough, provided it were true, as some think, that the Diesel engine could not burn the lower grade of oil.

As a matter of fact there is no reason to believe that the Diesel engine cannot burn this low grade of oil except that so far it has not done so. It has not done so mainly because it is necessarily more troublesome, and so far it has not been necessary to take that trouble. It is quite clear, however, that when the price differential becomes great enough, it will be worth while to go to some trouble

and expense to adapt the Diesel engine to this lower grade of fuel oil, or vice versa, and so wipe out the price differential entirely, which will restore to the motorship all of the advantages to which it is entitled.

To adapt the motorship to the burning of the lower-grade oil, which seems to be really the only step necessary to eliminate even the residual doubts remaining in the minds of American shipping interests, there are only two factors of any importance to be studied, namely, spraying of the oil and ignition temperatures.

It appears from all of the research work that has been done on spraying, particularly in connection with the spraying of oil in boiler furnaces with the so-called mechanical atomizers, that all oils can be sprayed equally well regardless of their other physical properties if they are brought by heating to the same viscosity. It would seem as if this should also be true when the oil is sprayed into a cylinder against a pressure of from 400 to 500 lb. per sq. in., and some experimental work already done confirms this as a reasonable conclusion, though it is not yet a commercially established fact.

If the heavier residual fuel oils have, as may be the case, a higher ignition temperature than the lighter ones, there may be some difficulties about ignition at the compression which has been used for the lighter fuels. In this case two remedies are available: one to raise the compression, which has the objection of overloading the bearings, framing or the running gear and consequently increasing weights to avoid this; and the other to use an igniting fuel in small amounts, not exceeding 10 per cent of the total injected before the main supply of fuel, as has been done in Europe in burning tar oil. As soon as it appears to be necessary American engineers will undertake the building of the auxiliary apparatus and make the modifications necessary to adapt any grade of oil to the oil engine that can be fed through pumps from storage tanks, and thus wipe out any price differential that may exist, or may develop in the future, with every prospect of success. In general, whatever appliances are successful with one type of engine will be successful with all, because engine differences are not such as will prevent the general adoption of a broad scheme of fuel-oil conditioning developed for this purpose.

It may be said, therefore, that America is about to enter on its program of motorship development and use, and in fact has actually entered it within the last year. The rate of adoption depends upon the speed with which established facts become recognized and known, and are followed by building orders. It is of considerable interest to note that the motor-car industry, in which America now leads the world, developed in Europe in quite the same way as the motorship industry, and it is not too much to expect that once American interests become convinced that the motorship is what the Europeans think it is, American motorship construction and operation will also lead the world.

Charles Edward Lucke.

What Happened in Italy

The recent attempt at industrial communism in Italy is of particular interest to engineers because of its development in the metal-working industries. Light has been thrown on the sequence of events and the underlying causes by the publication in *Current History* for December (The New York Times Company) of translations of official documents bearing on the situation, which form the basis of the following summary.

The quasi-revolution which occurred was a forcible attempt on the part of the workers to overcome the dominance of capital and to secure a position where labor would be raised from the position of a commodity, with wages subject to the laws of supply and demand, to that of a participant in the management of industry.

The background for the unrest is to be found in the fact that in Italy, more than any other country, special industries had been founded, or existing industries measurably increased, to meet the demands for war material, while the amount produced had depended almost entirely on the supply of raw materials secured from abroad. Under this situation the return to normal conditions, with curtailed production, must necessarily have produced more or less of a crisis. Coupled with this were two disturbing factors: one, the Russian Soviet influence, which became a powerful disturbing element; and the other, the extremely low scale of wages of the Italian workman previous to the war.

Wage advances did not keep pace with the advances in the cost of living, due in part to the prohibition of emigration, and the point was reached early last fall where the Federation of Italian Metal Workers made a demand for a 50 per cent increase in wages, which was promptly denied by the employers. Immediately a "stay-in" strike resulted, the men remaining in the factories and drawing their pay, but doing as little work as possible and reducing output by as much as 50 per cent. The employers then decided to close their plants and issued a lockout order. The workers retaliated by taking forcible possession of the factories and within a few days practically all the engineering and metallurgical plants in Italy were under control of the workers, a declaration being issued by the Federation to this effect on September 3.

The Government tried to effect a settlement, but the employers refused its proposals and the Government then made it plain that it would not use force to eject the workers from the factories, as this could not be done without bloodshed. Two days later the Employers' Federation passed a resolution demanding the evacuation of the factories as a condition for resuming negotiations and resolutions were framed upbraiding the Government for its "pretense of neutrality" and "its hesitation, not only to defend law and order, but to maintain the position of the state as a superior body or force, representative of the national interest, armed both with the will and capacity to guarantee the security of civil and of social life."

On September 12 an important conference of the workers of Milan decided to hand over to the General Federation of Labor the direction of the movement and the matter was put before the Government by the workers, calling for a modification in the relations which previously obtained between employers and employees. The gist of their statement is embodied in the following quotation:

> Such modification should tend to permit the latter (the workers), through the agency of their trade unions, to be in a position to know the real state of their industry, to be acquainted with its technical and financial workings, and to be able, through the work of their factory delegations (being offshoots of the trade unions) to coöperate in applying factory regulations, to control the appointment and dismissal of the employees, and thus to inspire the normal life of the factory with the necessary discipline.

The prime minister, Signor Giolitti, now intervened and what amounted to an ultimatum was presented to the employers calling upon them to accept the principle of the workers' demand for "controllo," this word being generally interpreted to mean participation or coöperation in factory management rather than absolute control, as has sometimes been assumed.

On September 16, the General Federation of Italian Employers submitted to this demand in a statement containing the following:

> It consents, provided that the other side be truly inspired by a like intention, to accept the principle of a control of industry to be carried out on the basis of legislative regulations, granted that such regulations do not establish any monopoly or superiority of the trade-union organizations, lay down the principle of the coöperation and joint responsibility of the various factors of production, be carried out to the advantage of the community, and abstain from interfering in the freedom of movement necessary to industrial undertakings.

The Government finally issued a degree calling for a commission of an equal number of members from each side to formulate suggestions for solving any questions that might arise in the application of factory rules and the appointment and dismissal of workers; calling upon workers of all classes to resume their employment.

It cannot now be predicted whether, as one writer has said, this "revolution" was only a "dress rehearsal" for a worse one to follow, or whether stability has probably been attained. An excellent summation of the situation as it now appears, however, has been given in the *Engineering Review* (London) for December, by Andrew Stewart, of the Consolidated Pneumatic Tool Company, Ltd., from which the following extracts are taken:

> What terminated the revolutionary experiment was the discovery that there was no money to pay wages at the end of the week, nor was there any money to purchase raw materials. Sellers of materials were not prepared to do business with people who apparently could not pay. A few managed to carry on for a week or two by selling what they could and applying the proceeds to pay wages, but it was soon found that the value of

the product was insufficient for the purpose; in other words, the business quickly became insolvent.

They also found that they had to face problems of policy and administration, which they were incapable of solving; in short, they had taken over a great commercial machine which they could not run. In their anxiety to secure all the supposed products of their labor, they discovered that they could not even produce sufficient to pay the worker his normal wage, while the capitalist could do so, and even get something for himself. The capitalist could work the machine; they could not; and the "profits" accruing from the workers' control were a will-o'-the-wisp.

One of the outstanding features of the "revolution" is that, while it has fizzled out, it has achieved some notable results. It has demonstrated that an intelligent and well-informed democracy is poor material for the revolutionary. A less intelligent democracy would have plunged Italy into an abyss of misery far beyond the worst that has ever occurred in Russia, for it is obvious that, while in an agrarian district a revolutionary change has an imperceptible immediate effect, since stocks of food and necessities generally are sufficient for a long period, in an industrial district the necessities of the workers can be met only by an immediate exchange of the products of industry for the necessaries of life, and anything which interferes with the flow of industrial products from the producer, or the return flow of food and other manufactured articles to the producer, must have an immediate and disastrous effect on the worker.

Fuel Efficiencies From a National Standpoint

There are several methods for determining the relative efficiency of fuels. This may be on the basis of the number of B.t.u.'s usefully obtained per pound of fuel; or the number of B.t.u.'s usefully obtained from one dollar's worth of fuel at the plant; or, again, the number of B.t.u.'s usefully obtained for each dollar of expenditure in connection with the fuel. The latter includes not only the cost of the fuel itself delivered at the plant, but all the direct and indirect items involved in handling the fuel up to the moment where it generates power, and possibly even afterward.

These methods of fuel appraisal are all on the B.t.u. basis and are concerned only with the individual conditions of the particular plant considered. There is a growing realization, however, that heat-unit efficiency is only one of the many items to be considered, and that a broader view, on a national basis, with due regard to fuel conservation and the interests of the public must be taken.

If a concern burns, say, 500 tons of coal daily, this means, roughly, ten gondola cars a day. These cars have to be hauled from the mine, possibly over a badly congested section of railroad. Delay and increased expenditure are thus created in the transportation of other freight vitally needed both by the purchasers of the coal and by other concerns in the same industrial district.

From a national point of view it would be well to consider whether it would not result in better overall efficiency if the concern in question were to use its fuel in some form which could be transported in such a way as not to interfere with the shipment of other freight.

From a national point of view, again, the consideration now being given to the utilization of coal at the mouth of the mine and the transportation of the fuel in the form of electric current to points where it is to be used, is of pressing importance. Electric current, however, cannot as yet be efficiently used for heating, of which modern industry requires a large amount; and in the generation at the mouth of the mine in the immense plants which would be required there would be difficulty, in many cases, in securing an adequate supply of water for condenser operation.

In a paper presented by Sir Arthur Duckham before a meeting of the Institution of Petroleum Technologists, held in London last October, the author advocates another solution of the problem—the development of a process for converting coal at the mine into gas and oil fuel. He feels assured that this dual end can be attained by the adoption of the vertical-retort system of gas making, combined with an appropriate water-gas plant. The basic idea is to utilize the heat in the coke through formation of water gas by passing steam through the hot coke. "During the war," he states, "it was possible to put these ideas into practice and in continuous-working vertical retorts it became possible with steaming to obtain over 20,000 cu. ft. of very serviceable gas per ton of coal instead of the 12,000 that used to be obtained previous to the war. It was further found that with the water gas ascending the retort, the hydrocarbons generated were protected from the coal and so gave a further amount of gas and lighter tar oils."

The scheme advocated by Sir Arthur Duckham, although somewhat different in method and intent, is in accord with the suggestion of Prof. R. H. Fernald in the December number of Mechanical Engineering, that an intensive study be made of low-temperature distillation processes to determine whether a combination of low-temperature distillation and the manufacture of by-product producer gas can be made a commercial success and constitute a solution of the natural-gas problem which this country now faces.

This whole subject is yet in a very undeveloped state. It is one that is bound to receive increasing attention and study and that may ultimately have an important bearing on fuel conservation as well as on the efficiency of plant operation, considered in their broader aspects from a national standpoint.

Utilization of Tidal Power

A great deal of attention has recently been given in England to the possibility of utilizing tidal power on a large scale. The British Ministry of Transport has conceived a grandiose scheme for the utilization of half a million horsepower from the tidal movements in the estuary of the river Severn, which empties into the Bristol channel at the junction of the Lower Avon, west of Bristol. The proposal, as stated in an interim report of the Water Power Resources of the Board of Trade, abstracted elsewhere in this issue, and as described in *The Engineer*, for December 3, 1920, is to construct a dam across the river where it is some 2½ miles wide, with a barrage, in portions of which are to be installed turbines and generators of a capacity in excess of one million continuous horsepower. About half that amount of power is to be available for distribution, the surplus energy being employed to pump water into a high-level reservoir placed at a short distance up the river. When by reason of the rise of tide in the Severn estuary below the dam it is no longer possible to work the turbines in the dam, water is to be allowed to flow from the reservoir through other turbines, thus producing a constant supply of half a million horsepower.

It follows, therefore, that for the full operation of the scheme there will have to be two gigantic hydroelectric stations, one of them, that in the dam, capable of generating upward of one million horsepower and the other, that in connection with the high-level reservoir, capable of producing over half a million horsepower. For portions of each day one or other of the two stations will be entirely inoperative, though for part of the time they would be working in parallel. The periods of working of the two stations would, of course, vary considerably because of the seasonal variations in the tides.

A striking feature of the proposal is that the water is to be forced into the high-level reservoir through a tunnel driven through more than a mile of solid rock. The tunnel is to be 40 ft. in diameter; that is, it will have nearly four times the cross-sectional area of an ordinary double-line railway tunnel.

Published statements about the cost of the development are very much at variance, ranging between $40,000,000 and $150,000,000; but it is claimed in the official report that even at the higher figure the project would be on a sound economic basis and would be a "paying proposition," not only effecting a saving in coal consumption of from three to four million tons per year, but allowing electricity current to be sold at a small fraction of present rates.

Professional Sections of the A.S.M.E.

Ten years ago the Committee on Meetings of the A.S.M.E. arranged for the formation of a number of sub-committees of specialists in different branches to secure papers and arrange for sessions in the special subjects in which they were interested. These sub-committees were instituted largely through the foresight of Dr. Charles E. Lucke, then a member of the Committee, with the underlying thought that the solution of problems worked out in one branch of engineering is often applicable and always

helpful in the solution of similar problems in other branches. It was felt that interchange of data in this way would be widely beneficial and lead to a broader understanding of the basic principles of engineering practice.

How well these ideas have worked out can be shown by reference to the sessions of a single sub-committee—that on Textiles, which has been conducted under the able chairmanship of Charles T. Plunkett, president of the Berkshire Cotton Manufacturing Company, Adams, Mass., and the secretaryship of the late E. W. Thomas, who was agent of the Boott Mills, Lowell, Mass. While the sessions of this sub-committee have been conducted in the interests of the textile industry, but few of the papers have dealt specifically with the production of textiles. Rather have they treated of the broader problems met with in the industry, of interest as well to those in other fields. Subjects have been treated such as the principles of valuing property, specifications for factory timbers, higher steam pressures, heating by forced circulation of hot water, heat transmission through various types of sash, sawtooth roof construction, industrial power problems, etc.

The success of the sessions sponsored by the various sub-committees, and the evident interest in the special subjects treated, finally led to the formation of Professional Sections which, beginning with the last Annual Meeting of the Society, took the place of the former sub-committees. Already eight such Sections have been formed, in most of which large numbers of members have designated their desire to become associated. In the Management Section, for example, there are 1230, in the Machine Shop 727, Fuel 614, Materials Handling 676, Power 1151, and Railroads 467.

A pleasing development in this Sections movement has been the formation of the Forest Products Section, which held a most interesting session at the Annual Meeting, an account of which appears in this number. This is the initial movement for special attention on the part of the engineers to the problems of the woodworking industry, and the diversity and character of the papers presented indicate the breadth and scope of this branch of industry, starting with the felling of the timber in the forest, and continuing with its transportation to the mill and its transformation into lumber or into the more finished products with which we are all familiar, ranging from furniture to matches. It is not unlikely that many of the problems in other branches of engineering will be found to have a direct bearing on those in the woodworking industry, and that, on the other hand, the ingenuity and skill which have so long been displayed by the inventive minds among the woodworking fraternity will prove enlightening to those in the more strictly engineering fields.

Bill Introduced in Senate to Make Metric System Only Legal Standard

A stringent bill "to fix the metric system of weights and measures as a single standard for weights and measures," and which goes to the extent even of curtailing personal liberties, was introduced in the Senate on December 16, 1920. Certain of its provisions are that from and after 10 years no one shall sell goods, charge for transportation of goods, or pay for work or labor, where weights and measures are involved, except by the metric system; and that after that time no one "shall use or attempt to use....any other system." Also, that from and after four years no one shall "manufacture or make for himself for use or purchase for use any weight or measure or weighing device....in any other system than the metric."

University of Illinois to Appoint Research Graduate Assistants

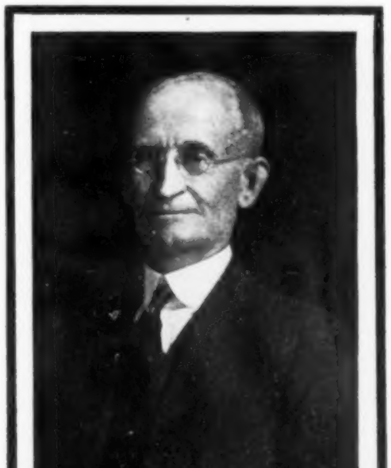
The University of Illinois now maintains 16 research graduate assistantships in the Engineering Experiment Station of that University, two of which have recently been established by the Illinois Gas Association, for investigation in the field of gas engineering. There will be 15 appointments to these assistantships this year, including the two in gas engineering. Appointments are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics or applied chemistry. These appointments must be accepted for two consecutive collegiate years, and for the successful accomplishment of the required work the degree of Master of Science is conferred. Nominations to these positions are made from applications received by the Director of the Station, Dean C. R. Richards, not later than March 10. Full information as to the form of application, funds available, etc., will be supplied upon application to the Director.

Frank Harvey Ball

In the death of Frank H. Ball in Detroit on November 12, 1920, the mechanical and engineering world lost one of its most active members, as practically all of his life was devoted to the invention and manufacture of useful mechanical devices.

Mr. Ball was born on May 21, 1847, in Oberlin, Ohio, and was educated in the grammar and high schools of Buffalo, N. Y. After some early experiences in a country sawmill on his father's farm he entered into the production of steam engines for drilling and operating oil wells. He brought out the well-known Ball automatic high-speed engine and founded the Ball Engine Co., of Erie, Pa., of which he was general manager from 1880 to 1890. He then formed the Ball & Wood Co., Elizabeth, N. J., acting as general manager of this firm until 1895, when he became general manager of the American Engine Co., Bound Brook, N. J., producing the American Ball engine.

Retiring from the steam-engine business several years ago, he and his youngest son invented and put on the market the Ball



Frank Harvey Ball

& Ball carburetor for gasoline engines. In 1913 he became manager of the carburetor department of the Penberthy Injector Co., Detroit, Mich., a position which he still held at the time of his death.

Mr. Ball was not only a successful engineer but also an enthusiastic yachtsman. From his boyhood days on the Niagara River he always owned some kind of a sailing craft and was the winner of many sailing races in Buffalo, Erie and Cleveland. For several years his sailing houseboat, the *Sommerheim*, aroused great enthusiasm and interest in Great South Bay, L. I. In Erie, his devotion to yachting resulted in the formation of the Erie Yacht Club, of which organization he was made the first and only honorary member.

Mr. Ball became a member of the Society in 1883. He was one of its managers from 1888 to 1891 and from 1894 to 1896 a vice-president. He also belonged to the Society of Automotive Engineers, in which organization he took an active interest.

NEW HONORARY MEMBERS OF THE A.S.M.E.

At the Annual Meeting of The American Society of Mechanical Engineers held in New York last December, honorary memberships in the Society were conferred upon six distinguished engineers, three of whom are residents of European countries, the Honorable Sir Charles Algernon Parsons, of London, England, Lord William Weir, of Glasgow, Scotland, and Grande Ufficiale Ingegnere Pio Perrone, of Genoa, Italy. Brief sketches of the achievements of these honorary members follow.

Captain Robert Woolston Hunt

A full biographical sketch of Captain Hunt was published in the January 1919 issue of Mechanical Engineering, on the occasion of his eightieth birthday anniversary celebration. Captain Hunt, now head of the Robert W. Hunt and Company, consulting engineers, of Chicago, was for many years connected with the Cambria Iron Company and the Troy Steel and Iron Company, during which time he assisted in many notable developments in the iron and steel industry.

Captain Hunt has been a member of this Society since 1880. He was president in 1891. He is also a member of the American Institute of Mining and Metallurgical Engineers, the American Society of Civil Engineers, the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Iron and Steel Institute of England, the American Society for Testing Materials, and other societies. He was awarded the John Fritz Medal in 1912 "for his contributions to the early development of the Bessemer process."

Dr. Samuel M. Vauclain

Doctor Vauclain is senior vice-president of the Baldwin Locomotive Works of Philadelphia. He has been with this company since 1883, first in charge of all buildings and equipment of the entire works, methods of manufacture and devising of special tools and machinery, and later in full charge of the plant, including manufacturing.

During the war he was special officer of the United States Government, supervising the manufacture and production of heavy ordnance. In 1917 he was appointed chairman of the Cars Committee and the coöperative Committee on Locomotives of the Council of National Defense.

The University of Pennsylvania conferred upon him the honorary degree of Doctor of Science in 1906, and he received awards from the Paris Exposition in 1900, from the Buffalo Exposition in 1901, from the St. Louis Exposition in 1904, and from the Seattle Exposition in 1908. He has been a member of the A.S.M.E. since 1894 and was vice-president from 1904 to 1906. He is also a member of the Institution of Civil Engineers of Great Britain, the American Society of Civil Engineers, the American Institute of Mining and Metallurigcal Engineers, the American Railway Engineering Association, the American Philosophical Society, and other organizations.

Rear-Admiral Robert Stanislaus Griffin

Rear-Admiral Griffin, Washington, D. C., was Engineer-in-Chief of the Bureau of Steam Engineering, which during the war covered all steam and internal-combustion engines for the Navy, took care of the upkeep of 2000 vessels, and furnished protection for vessels by the construction of emergency submarine destroyers.

The notable achievements of the Bureau during the war were largely due to the efficiency and influence of Admiral Griffin. By using electric welding in the repair of about fifty German merchant vessels seized by our Government, he made it possible, in five months, to transport to France nearly 600,000 troops. The Bureau improved the wiring for gun-fire control systems on all installed communication systems for the service of the guns on transports and ships carrying armed guards and provided recognition signals on all vessels operated by the Navy.

Other achievements of far-reaching importance were securing control of the wire output of this country, the perfection of the submarine detector, and the installation of numerous radio equipments on vessels and at coastal stations.

Honorable Sir Charles Algernon Parsons

The commercial development of the steam turbine and its application to useful purposes on a comparatively large scale, one of the distinct achievements in steam engineering during the latter part of the nineteenth century, has become inseparably associated with the name of Charles Algernon Parsons, of London.

In 1884 Sir Charles became a partner in the firms of Messrs. Clarke, Chapman, Parsons and Company. The electrical industry at that time being the latest development of engineering, he conceived the idea that a high-speed, direct-coupled engine was required to drive the dynamo and that the steam turbine was the engine to do it.

His inventions include non-skid chains for automobile tires; an auxetogramophone in 1898; and the compound turbine known by his name, introduced about 1884, improved by a condenser in 1891, and adapted for maritime use on the *Turbinia* in 1897. About 1910 he invented a geared turbine.

He is the author of many publications and monographs on the steam turbine. He is a member of the Institution of Civil Engineers of Great Britain, the Institution of Mechanical Engineers, and of numerous other scientific and engineering societies.

Lord William Weir

Among the many engineers who did splendid service during the war, none served better than Sir William Weir, of Glasgow, Scotland, late British Director-General of Aircraft Production. As a member of the firm of Messrs. G. and J. Weir, Ltd., Glasgow, he took an active part in the manufacture of munitions immediately after the opening of hostilities, not only by helping to extend greatly the operations of his own company, but also by taking a leading share in the organization of the West of Scotland area for war purposes. His energy and his genius for work of this kind were recognized early, and in 1915 he was asked by Mr. Lloyd George to join the Ministry of Munitions, and later to undertake the duties of Director of Munitions in Scotland. Later still he was transferred from Glasgow to London and appointed Controller of Aeronautical Supplies to the Army and Navy. Afterward he was made a member of the Air Board; in December 1917, he was appointed Director-General of Aircraft Production in the Ministry of Munitions, and in January 1918 he was made a member of the newly established Air Council. He was knighted early in 1917 as a recognition of the value of his services to the nation. He is a native-born and home-trained Glasgow man, has had a wide experience of engineering practice and problems, and is an enthusiast in original research and in designing, and an organizer of outstanding ability.

Lord Weir is a vice-president of the Institution of Mechanical Engineers and a member of the Institution of Civil Engineers. He was president of the Institution of Marine Engineers for the year 1920.

Grande Ufficiale Ingegnere Pio Perrone

Signor Perrone is president of Ansaldo and Company of Genoa, Italy, which firm prior to the war was engaged in shipbuilding, making of turbines, construction of locomotives and building of electric machinery.

At the beginning of the war the firm offered to turn over its establishment to the Italian government for making large guns. The offer was not accepted but it went ahead and made guns after the best French designs, and, without a single order from the Italian government, completed two thousand pieces. After the Caporetto disaster Italy turned to the Ansaldo organization for guns, and its pieces were placed in the field at once and performed a feat which stopped the advance of the Austrians.

The firm grew to employ one hundred thousand men and women, and in the last two years of the war it bought in America and shipped to Italy in its own steamers war material which cost about fifty million dollars. It supplied ten thousand cannon, three thousand aeroplanes, many millions of projectiles and several scores of warships, torpedo boats and submarines for the use of the Italian army and navy.

AN ANALYSIS OF MACHINED FITS

(*Continued from page 133*)

The two remaining sketches, Figs. 11 and 12, show combinations which occur frequently in machine design.

Question 21. Will you kindly give your practice in such cases?

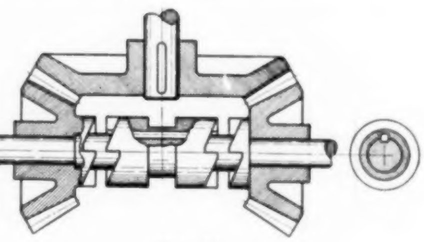


Fig. 11

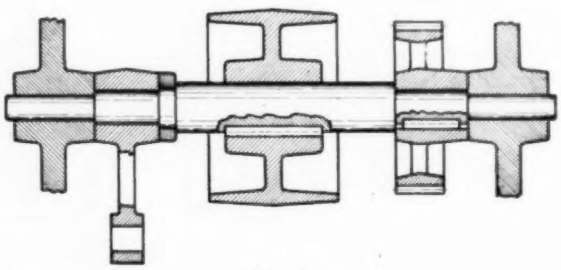


Fig. 12

Please bear in mind that the Committee has no desire that its report shall impose arbitrary standards in any case. Its first work consists in securing data as to the best present practice in this country, with the sole aim of aiding interchangeable manufacture in every way possible. Your coöperation will aid greatly in reducing manufactu ng costs in many places and in improving our already high standards of manufacture.

Engineering Council Merges into Council of F.A.E.S.

Last Meeting of Engineering Council—Work of Various Committees and Departments Taken Over by American Engineering Council—Classification and Compensation of Engineers—National Public Works Department Association

ON January 1, 1921, Engineering Council, which was established in 1917 by the United Engineering Society to provide coöperation between engineering societies for the consideration of questions of general interest to engineers and their relations to the public, and to provide a means for united action upon questions of common concern to engineers, merged into American Engineering Council, the executive body of The Federated American Engineering Societies. The transition brings to American Engineering Council the experience and knowledge gained by the Engineering Council and its various departments, as well as many of the individuals who have carried on the work of the Engineering Council.

The final meeting of Engineering Council was held in Washington on December 16, 1920. The morning session was devoted almost entirely to the closing of the affairs of the Council. Unfinished business and incompleted projects were referred to the United Engineering Society with the suggestion that they be laid before the new American Engineering Council with favorable recommendations.

The principal action of a continuing nature taken by the Council was the adoption of the resolution to the effect that the present financial stringency and the prospect that Federal revenues during the next year will not equal the Government expenses, make it a matter of good citizenship for every considerate person to avoid advocating expansion of Government activities; that in consequence of this belief, Engineering Council would endeavor to set the example by withdrawing its previously enlisted support of efforts to secure increased appropriations for certain Government engineering projects.

A committee consisting of Philip N. Moore, J. Parke Channing and Alfred D. Flinn was appointed to prepare a final report of the Council which would be also a history of its activities.

During the afternoon calls were paid to the chiefs of technical bureaus of the Government, the Chief of Engineers, U. S. Army, Chief of Yards and Docks of the Navy Department, Director of U. S. Reclamation Service, Director of U. S. Geological Survey, and Director of the Bureau of Mines.

In the evening the hosts of the afternoon and a number of the members of the new American Engineering Council were guests at a farewell dinner of the Council. Tokens of esteem were presented to J. Parke Channing, chairman of the Council for three years, who was largely responsible for the Washington office of the Council and the movement for a National Public Works Department, to the Secretary, Alfred D. Flinn, and also to M. O. Leighton, the Washington representative of the Council as well as chairman of the National Public Works Department Association.

Important Committees of American Engineering Council

A number of the important committees and departments of Engineering Council have been requested to continue their work, acting as committees of American Engineering Council. Brief notes are here given on some of these and on other new committees appointed, and fuller notes on the Committee on Classification and Compensation of Engineers and the National Public Works Department Association.

The Patents Committee, of which E. J. Prindle is chairman, will continue to work for an increase in both the pay and personnel of the United States Patent Office, as provided for in the Nolan Bill. The Washington office of Engineering Council has taken over by the new Council and will serve the member-societies of the F.A.E.S. as this office has in the past served the member-societies of the United Engineering Society. A. C. Oliphant as acting assistant secretary is in charge.

The Engineering Societies Employment Bureau, with Walter V. Brown retained as manager, will be continued by American Engineering Council. Until such time as a more comprehensive plan can be formulated, the secretaries of the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers will act as managers of this department. Applicants for employment will be divided into two classes, preferred and ordinary, the preferred applicants being those who are members of constituent societies of American Engineering Council, and the ordinary applicants all others.

J. Parke Channing, formerly chairman of Engineering Council, becomes chairman of the Committee on Public Affairs of American Engineering Council. This committee will handle the governmental activities of the F.A.E.S.

The elimination of waste in industry will be one of the chief tasks of American Engineering Council. A committee has been appointed to investigate this important phase of industrial development.

Colonel William Barclay Parsons is chairman of a Committee on Military Affairs, and also a Committee on New York State Government Reorganization. D. L. Hough heads a Russian-American Committee, the aim of which will be to bring the engineers of the United States and Russia closer together.

Classification and Compensation of Engineers

One of the most important of the committees whose work will be carried on by the American Engineering Council is the Committee on the Classification and Compensation of Engineers. A final report recently submitted by the chairman of the committee, Arthur S. Tuttle, and the secretary, Charles Whiting Baker, reviews briefly the activities of the committee since the time of its organization in April 1919.

The first stage of its work was completed in December 1919, at which time a report of the work accomplished was presented to Engineering Council, together with recommendations as to he adoption of a classification of engineers in governmental and railroad services and a tentative plan for compensation and promotion. An abstract of this report was published in the February 1920 issue of MECHANICAL ENGINEERING.

During the year 1920 a campaign was inaugurated on behalf of the classification which had been adopted by Engineering Council with a view toward securing its general adoption and recognition as a standard for all branches of engineering service. A canvass was made of over 600 societies, associations and individuals and an analysis of the replies received shows that the endorsement of the classification is practically unanimous. The classification has actually been put into effect in a number of instances and the salary schedule has generally been endorsed.

Although the Committee has no method of measuring the results of the publicity work it has done nor the extent to which its recommendations have been followed by industrial concerns and engineering corporations, it is of the belief that more and better results have been produced than the returns at hand indicate. The Committee pointed out the need of a further publicity program to educate legislators and the general public as to the importance of the services of the engineer and also to establish personal contact with representative engineers in various parts of the country, impressing on each individual and also upon the various engineering societies the necessity of coöperation in the movement.

The final recommendations of the Committee deal with the following matters:

1 Provision for the immediate increase in compensation of the engineering staffs of the Federal Government

2 Conference with a committee of American Railway Engineering Association for the purpose of bringing about the acceptance of a common standard for the classification of engineers

3 Investigation to determine the relation between engineering charges and the cost of work supervised.

These matters have been the subject for special studies and reports during the year.

The American Engineering Council has already appointed a Committee on the Classification and Compensation of Engineers with Mr. Tuttle as chairman.

National Public Works Department Association

American Engineering Council, which voted on December 17, 1920, to take over the activities of Engineering Council, will continue the campaign to reorganize the Department of the Interior by the establishment of a National Department of Public Works. This campaign has been conducted by the National Public Works Department Association which was organized in April 1919 under the auspices of Engineering Council.

The work of this organization, while not completed, has reached a point where the establishment of a Department of Public Works seems practically assured, as is shown in an abstract of the report of M. O. Leighton, chairman of the Association, published in the January issue of Mechanical Engineering, p. 60, and in a similar report submitted by C. T. Chenery, secretary of the Association. "This was the first successful effort of the engineering profession," stated Mr. Chenery, "to directly influence the national thought and national policy." He reviewed the progress of the movement and spoke in appreciation of those to whom the engineering profession is particularly indebted for their active and effective work in the campaign, many of whom will continue their services by supporting the American Engineering Council in its efforts to bring about the creation of the new department.

Engineering and Industrial Standardization

A.I.E.E. Sponsor for Rating of Electrical Machinery

The American Institute of Electrical Engineers was designated as sponsor for the rating of electrical machinery by the American Engineering Standards Committee at its meeting on December 4, 1920, and the responsibility for the work has already been officially accepted by the Institute. A sectional committee, which will include official representatives of the Electric Power Club, the National Electric Light Association, and various other interested bodies, is being fo:med to carry out the work.

These arrangements have been made at the request of the electrical industry, in order to prepare as quickly as possible for the next meeting of the Rating Committee of the International Electrotechnical Commission, at which questions of great importance to the industry, including the fundamental basis of rating, will be taken up. At the last meeting of the Rating Committee in Brussels in March 1920 the American delegates presented a proposal for a system of rating based upon the hot-spot principle, which was tentatively adopted by the Rating Committee and published as a recommendation to the various national bodies composing the Commission, for official adoption by the Commission at its next meeting.

Standardization of Zinc

The American Society for Testing Materials and the American Zinc Institute have accepted joint sponsorship for the standardization of zinc under the auspices and rules of procedure of the American Engineering Standards Committee.

The Association Belge de Standardisation has suggested international standardization of the following matters pertaining to zinc: grades of commercial zinc; gage thicknesses and tolerances for sheet zinc; methods of sampling and determining moisture content of ores; and methods of analysis of ore and spelter. The American committee will work along the lines of the Belgian suggestion, but the work will not be confined to these points.

The Belgian Association has suggested similar work on the other non-ferrous metals.

Terminal Markings for Electrical Apparatus

The Electric Power Club has been designated as sponsor for the standardization of terminal markings for electrical apparatus. A sectional committee responsible for the work, and upon which all organizations interested in the subject will be officially represented, is being organized.

At the Brussels meeting of the International Electrotechnical Commission in March 1920 some of the European delegates proposed a method for marking terminals of transformers. The American delegates suggested that it would be preferable to treat the more general subject of terminal markings for electrical apparatus consistently. As a result the Americans were requested to propose a systematic plan for the whole subject.

The Electric Power Club has already done a large amount of work on the subject and has developed a general plan which is in wide use among American manufacturers. Parts of the plan, particularly the part relating to transformers, have been adopted by other organizations, including the American institute of Electrical Engineers and the National Electric Light Association.

It is hoped to secure agreement of all interested bodies on a general plan for representation at the next meeting of the International Electrotechnical Commission.

Correlation of Standardization Work in the Mining Industry

At an informal conference, held in Chicago on August 30, 1920, of representatives of leading organizations interested in the standardization of mining equipment and practice, it was unanimously voted to recommend to the American Engineering Standards Committee that there should be organized a General Correlating Committee for Mining Standardization; that this committee should be made up of representatives of organizations which are now engaged in standardization work, or which might be expected to engage in it; and that the committee might well be started with a nucleus of two representatives of each of the leading national organizations interested in the subject. In compliance with this recommendation the American Engineering Standards Committee invited the five organizations mentioned below to designate two members each to represent them upon such a General Correlating Committee, with the understanding that the nucleus so formed might enlarge itself. These representatives are as follows:

1 American Institute of Mining and Metallurgical Engineers: Graham Bright, Howard N. Evanson

2 American Mining Congress: Chas. A. Mitke, Warren R. Roberts

3 Mining and Metallurgical Society of America: E. S. Berry, B. Britton Gottsberger

4 National Safety Council: F. P. Sinn, S. J. Williams

5 U. S. Bureau of Mines: E. A. Holbrook, O. P. Hood.

The Committee has held one meeting. Summaries are being prepared of the standardization work now in progress in the various organizations. The work of the committee will include such matters as (1) delimiting specific projects which might be most advantageously handled as units; (2) recommending the order in which the various projects should be taken up in order that the needs of the industry should be served best; and (3) making recommendations as to what bodies should act as sponsors for specific projects, and as to what bodies should be represented upon the sectional committees for such projects.

LIBRARY NOTES AND BOOK REVIEWS

Aircraft and Automobile Materials of Construction. Vol. 1. Ferrous Materials. By Arthur W. Judge. Sir Isaac Pitman & Sons, Ltd., London and New York, 1920. Cloth, 6 × 9 in., 755 pp., illus., charts, tables, diagrams, $9.

This book has been written for the user of the ferrous materials employed in the construction of automobiles and aircraft and in general mechanical construction. It is therefore not concerned with the metallurgical processes to which these materials may have been previously subjected, but with their composition, strength and properties as received from the steel manufacturer, and with modes of heat and other treatment. The work covers a wide range, and is intended as a reference work for designers and builders of machines.

Application of Dyestuffs to Textiles, Paper, Leather and Other Materials. By J. Merritt Matthews. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 × 9 in., 784 pp., illus., tables, $10.

The present volume is an outgrowth of the author's earlier work, Laboratory Manual of Dyeing and Textile Chemistry, but has been broadened in scope to appeal to the interest, not only of students, but of all those concerned in the application of dyestuffs. The author has endeavored to incorporate the latest knowledge of the subject. Contains an eighteen-page bibliography.

Applied Naval Architecture. By W. J. Lovett. Longmans, Green & Co., New York, 1920. Cloth, 6 × 9 in., 664 pp., charts, tables, diagrams, $12.

The present work is a specialized treatise on the design and construction of moderate-speed merchant vessels, 350 ft. and upward in length. As naval architecture is not an exact science, absolutely accurate solutions are not necessary in many cases, and for these the author has given special attention to approximate methods, whereby results may be obtained rapidly.

Calcul des Organes des Machines. By J. Boulvin. Gauthier-Villars et Cie, Paris, 1921. Paper, 7 × 10 in., 524 pp., diagrams, charts.

The present work deals with the calculation of boilers, cylinders, pipe systems, rotating and reciprocating machinery, eccentrics, gearing and transmission systems. Throughout, it is concerned with the determination of their dimensions from the resistance of materials, so that the tension or deformation will not exceed the limits desired. Empirical formulas are avoided. Numerous difficult problems have been given special attention and are treated in a novel manner.

Compressed Air Plant; The Production, Transmission and Use of Compressed Air, with Special Reference to Mine Service. By Robert Peele. Fourth edition, revised and enlarged. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 × 9 in., 529 pp., illus., diagrams, tables, $4.50.

This volume deals with the varied uses of compressed air in engineering, particularly in mining, tunnelling, quarrying and other work involving rock excavation. A chapter on the measurement of air consumption has been added to this edition, and also information on air-lift work. Typographical errors have also been corrected.

Detail Design of Marine Screw Propellers. By Douglas H. Jackson. Sir Isaac Pitman & Sons, Ltd., London and New York, 1920. Cloth, 6 × 9 in., 104 pp., tables, charts, diagrams, $2.50.

The author feels that many works on screw-propeller design carry theoretical considerations too far for the average designer. He therefore here presents, in small compass, an outline of the accepted theories, a full treatment of the practical application of them, and a short description of the various manufacturing methods. A chapter on repair work is also included.

A Dictionary of Chemical Terms. By James F. Couch. D. Van Nostrand Co., New York, 1920. Cloth, 5 × 7 in., 208 pp., $2.50.

This volume is designed to serve the convenience of readers of chemical literature by providing accurate definitions for the complex terminology of this science, in convenient form. The treatment of the terms lies between that of a standard dictionary of the English language and that of an encyclopedia.

Ein Neues Prinzip für Dampf- und Gasturbinen. By Konrad Baetz. Otto Spamer, Leipzig, 1920. Paper, 6 × 10 in., 80 pp., illus., diagrams.

The author states that the investigations described in this monograph have occupied his attention for twenty years, but that his inability to construct a model machine has caused him to publish this record of his work, in the hope that further investigations may be stimulated thereby. The problem under consideration is that of combining, in a single machine, the modes of action of the reciprocating steam engine and the steam turbine. This the writer accomplishes by a "cellular" turbine, whose rotating member is composed of cells, in which the steam alternately is compressed and expanded. The book gives the theoretical calculations supporting the author's theory and the results obtained by experiment.

Electric Traction and Transmission Engineering. By Samuel Sheldon and Erich Hausmann. Second edition, revised. D. Van Nostrand Co., New York, 1920. Cloth, 5 × 8 in., 319 pp., illus., diagrams, charts, $3.

This textbook attempts to present a perspective view of the design of a complete railway installation, from the cars to the power-station, to indicate the nature and sequence of the various problems entailed, and to suggest or illustrate methods for their solution. It is intended to assist students and young engineers to discriminate as to the pertinency or necessity of specific details.

Electro-Deposition of Metals. By George Langbein. Translated, with additions, by W. T. Brannt. Eighth edition, revised and enlarged. H. C. Baird & Co., Ind., New York, 1920. Cloth, 6 × 9 in., 875 pp., illus., diagrams, $7.50.

This book is intended as a reference book and practical guide on electroplating, based upon the scientific principles underlying the art, but devoid of mathematical technicalities. The present edition has been thoroughly revised and modernized, and new methods have been added wherever necessary.

Encyclopedia of Marine Appliances. Compiled by Alexander McNab, 1920. The McNab Company, Bridgeport, Conn. Cloth, 9 × 12 in., 206 pp., illus., $5.

An interesting catalog of marine appliances, made or sold by the publishers.

The Engineering Draughtsman. By E. Rowarth. E. P. Dutton and Company, New York. Cloth, 6 × 9 in., 269 pp., diagrams, tables, $5.

This book, intended for those familiar with the elementary principles of engineering drawing, is a collection of ninety-six exercises, arranged to illustrate the application of the principles in the production of working drawings. These examples show how working drawings of details are made from information obtained from general assembly drawings; how assembly drawings are made from detailed working drawings; how detailed working drawings are modified in shape and size to suit new machines. The plates cover a wide range of work and are taken from drawings of commercial machines.

Handbook of Building Construction. Editors-in-chief, George A. Hool and Nathan C. Johnson. First edition, first impression. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 × 9 in., 2 vols., frontispiece, illus., diagrams, tables, $10.

This has been prepared to provide the architect, engineer and builder with a reference work covering thoroughly the design and construction of the principal kinds and types of modern buildings, and their mechanical and electrical equipment. Each section is the work of a specialist, and although condensed, gives the

information usually needed for reference by the engineer in practice. The volumes are fully illustrated by diagrams and figures.

Handbook of Engineering Mathematics. By Walter E. Wynne and William Spraragen. Second edition, revised and enlarged. D. Van Nostrand Co., New York, 1920. Cloth, 4 × 7 in., 290 pp., diagrams charts and tables, cloth.

This is an endeavor to present in handy form and convenient pocket size, references to the theoretical and applied mathematics used in engineering. It contains the underlying engineering data and applications, as well as the mathematical formulas. The present edition has been enlarged by additions to the mathematical sections and tables of functions, and the physical and chemical constants have been revised.

The Handbook of Industrial Oil Engineering. By John Rome Battle. Vol. 1. Lubrication and Industrial Oil Section. J. B. Lippincott Co., Philadelphia, cop. 1920. Cloth, 5 × 8 in., 1139 pp., illus., diagrams, tables, charts. $10.

This handbook is intended to assist in the intelligent selection and use of lubricants for all purposes, and has been prepared for manufacturers, sellers and users of industrial oils. The range covered is a wide one and includes the use of oils in heat-treating steel, in foundry practice, in soap making and as insecticides, as well as for lubrication. Specific information on the use of oils in the major industries is given. The book also has a section on marketing and a selection of mathematical and engineering data.

Higher Mechanics. By Horace Lamb. University Press, Cambridge, 1920. Cloth, 6 × 9 in., 282 pp., frontispiece, diagrams. $8.

This treatise includes three-dimensional kinematics, statics and dynamics, and may be regarded as a sequel to the author's two former treatises on statics and dynamics. The author attempts to confine his attention to matters of genuine kinematical or dynamical importance, and to avoid those of purely mathematical or historical interest. The book is designed as an introduction to the subject.

The Human Motor, or the Scientific Foundation of Labour and Industry. By Jules Amar. E. P. Dutton & Co., New York, 1920. Cloth, 6 × 9 in., 485 pp., illus., charts, diagrams, $10.

This book is a study of the human body as a motor and of the conditions that govern its effectiveness. The author has collected the physiological data which govern the efficiency of human work and has also included a brief summary of the principles of mechanics. The work of Chauveau and Taylor is discussed and criticized, and the latter's system carefully examined.

Industrial Stability. Edited by Carl Kelsey. (Vol. 90 of the Annals of the American Academy of Political and Social Science) Philadelphia, 1920. Paper, 7 × 10 in., 168 pp., $1.

The thirty-four papers here brought together as contributions to current discussion of the general subject, present the views of business men, manufacturers, philosophers, social workers, attorneys and economists on one of the most pressing questions of the day. The major topics are the trend toward industrial democracy, labor representation in industrial management, collective bargaining, securing production, and industrial stability; and the individual papers are grouped accordingly.

Laboratory Manual of Testing Materials. By William Kendrick Hatt and H. H. Scofield. Second edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 5 × 8 in., 188 pp., tables, chart and diagrams, $1.25.

This concise manual of instructions for procedure in the usual physical tests of structural materials is the outcome of the operation of the Laboratory for Testing Materials of Purdue University. It is intended as a guide in class work and investigations and to explain the details of the methods. The present edition has been thoroughly revised in accordance with current practice.

The Manufacture of Sugar from the Cane and from the Beet. By T. H. P. Heriot. Longmans, Green and Co., New York, 1920. (Monographs on industrial chemistry.) Cloth, 6 × 9 in., 436 pp., plates, diagrams, tables, $8.50.

This is a systematic description of the manufacture of sugar, covering all the operations and elucidating the principles that underlie them. Detailed descriptions of sugar machinery are omitted, as the book is intended to give a broad but accurate view of the whole industry, rather than to cover the technical details of manufacture.

Modern Explosives. By S. I. Levy. Sir Isaac Pitman & Sons, Ltd. London and New York, 1920. (Pitman's common commodities and industries.) Cloth, 5 × 7 in., 118 pp., frontispiece, illus., $1.

Upon the basis of experience gained during the war, the author of this little book gives an account, for general readers, of the modern explosive industry. Stress is laid on the interdependence of modern industry and the necessity of viewing all research and productive activity as a whole, not only for purposes of defense, but to insure the well-being of the community.

Powdered Coal as a Fuel. By C. F. Herington. Second edition, revised and enlarged. D. Van Nostrand Co., New York, 1920. Cloth, 6 × 9 in., 340 pp., frontispiece, illus., diagrams, tables, $4.50.

In the two years that have elapsed since the first appearance of this work, the use of powdered coal has been greatly extended, and the book is therefore reissued in order to present the economies that have been effected and the various uses to which powdered coal has been applied. The processes for powdering coal, the suitable coals and the methods of using it are described in the introductory chapters. The remainder of the book gives the results obtained in various industries. A twenty-page bibliography is included.

Power Wagon Reference Book, 1920. Edited by Stanley L. Phillips. The Power Wagon Publishing Co., Chicago. Cloth, 9 × 21 in., 880 pp., illus., tables, diagrams.

This volume is a combination buyers' directory, encyclopedia, and engineering handbook of motor trucks. The first section, on motor trucks, comprises lists of makers of trucks and truck parts, both gas and electric, tables of specifications, blueprints and articles on the use of trucks in various industries. Trailers, bodies and tractors are given similar treatment in succeeding sections, and these are followed by a collection of articles of a general nature. The book concludes with a classified buyers' directory.

Pumping by Compressed Air. By Edmund M. Ivens. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 × 9 in., 270 pp., illus., tables, charts, diagrams, $4.

The intent of the book is to provide the student with a comprehensive theoretical study of the subject and the operating engineer with information on the economic essentials of the actual installation. The present edition has been enlarged by thirty pages of reliable operative data.

Rapid Methods for the Chemical Analysis of Special Steels, Steel-Making Alloys, Their Ores and Graphites. By Charles Morris Johnson. Third edition, revised and enlarged. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 × 9 in., 563 pp., illus., tables, $6.

This collection of analytical methods, by the chief of a large steel-works laboratory, represents the results of long experience in the rapid examination of steel-works materials. Many methods are original. The present edition has been expanded to include a considerable number of new methods which have been developed since the last revision of the book.

Relativity; The Special and the General Theory. By Albert Einstein. Translated by R. W. Lawson. Henry Holt & Co., New York, 1920. Cloth, 6 × 9 in., 181 pp., port., $3.

Dr. Einstein has attempted, as far as possible, to give an exact insight into the theory of relativity to those readers who are interested in it, from a general scientific and philosophical viewpoint, but who are not conversant with the mathematical apparatus of theoretical physics. The book assumes more than an elementary education and, despite the shortness of the book, a fair amount of patience and force of will, will be necessary to comprehend it. The author, however, has spared no pains in the endeavor to present the main ideas in the simplest and most intelligible form.

THE ENGINEERING INDEX

(Reg. U. S. Pat. Off.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

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ACCIDENTS

Building Construction. Keeping Track of Construction Accidents. Contract Rec., vol. 34, no. 45, Nov. 10, 1920, pp. 1078–1081. Describes systematic method of checking safety. Report adopted by Construction Section of Nat. Safety Council.

AERONAUTICAL INSTRUMENTS

Bearings, Efficiency of. The Efficiency of Small Bearings in Instruments of the Type Used in Aircraft, F. H. Norton. Nat. Advisory Committee for Aeronautics, report no. 94, 1920, 10 pp., 18 figs. Research at laboratory of Nat. Advisory Committee for Aeronautics, Langley Field, Virginia. Static and running friction for thrust and radial loads, was determined for several conical pivots and for plain cylindrical and ball bearings. It was found that for given small load conical pivots give less friction than any other type. When load exceeds 1000 grams ball bearings give less friction than pivots and stand shocks ana wear better.

Inclinometers. Airplane Flight Instruments, Kurt Bennewitz. Aviation, vol. 9, no. 11, Nov. 29, 1920, pp. 346–348, 8 figs. Inclinometers with stationary system of references, and with moving system of reference. Translated fron Technische Berichte.

AERONAUTICS

Standard Atmosphere. Standard Atmosphere (Sur l'atmosphère standard), P. Grimault. Aéronautique vol. 2, no. 14, July 1920, pp. 93–96, 6 figs. Standard adopted by Ministry of Aeronautics and Aerial Transport of France for official testing of aeroplanes.

Tests. Distribution of Pressure on Cylinder Whose Generatrix is Perpendicular to the Air Current (Sur la distribution des pressions autour des cylindres dont les génératrices sont perpendiculaires au courant d'air) A. Toussaint. Aéronautique, no. 11, April 1920, pp. 493–500, 19 figs. Records of experiments. (Concluded.)

AEROPLANE ENGINES

Aeromarine U-8. Aeromarine U-8 180 Hp. Engine. Aviation, vol. 9, no. 12, Dec. 6, 1920, pp. 387–388, 3 figs. Water-cooled 8-cylinder V-type. Total weight of engine, 550 lb.

American. Modern Aviation Engines—VI, K. H. Condit. Am. Mach., vol. 53, no. 23, Dec. 2, 1920. pp. 1042–1044, 6 figs. Representative American designs for commercial aviation.

Carburetors. See CARBURETORS.

German Diesel. A German Diesel Airplane Engine. Aviation, vol. 9, no. 9, Nov. 15, 1920, pp. 287–288, 2 figs. Engine operates on two-cycle principle. It has no carburetor, fuel being injected directly into cylinders. It has no valves. There are two opposed pistons per cylinder and two crankshafts connected by gearing at one end.

Italian. Modern Aviation Engines—V, K. H. Condit. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 936–938, 5 figs. Italian types.

Pressure Gages. Pressure Gages for Airplanes. Aviation, vol. 9, no. 11, Nov. 29, 1920, pp. 357–8, 2 figs. Instructions for installing gages.

Starters. Comparative Test of Auxiliary Starting Devices for the Liberty Engine. Air Service Information Circular, vol. 2, no. 3, Sept. 25, 1920, 7 pp., 6 figs. Object of test was to compare ease of starting of 12-cylinder Liberty engine equipped with two auxiliary starting devices designed by Engineering Division, Air Service.

New Ignition End Bijur Airplane Engine Starter. Automotive Manufacturer, vol. 62, no. 8, Nov. 1920, pp. 31–32, 2 figs. Details of new self-contained starter, particularly adapted to Liberty motors.

Wright. New Wright Aeronautical Engine. Aviation, vol. 9, no. 13, Dec. 13, 1920, pp. 420–423, 7 figs. Latest design manufactured by Wright Aeronautical Corp'n, manufacturers of Wright-Hispano engine.

AEROPLANE PROPELLERS

Blade-Screw Theory. A Few Remarks Concerning Some Fundamentals of the Theory of Blade-Screws, George de Bothezat. Aeronautical Jl., vol. 24, no. 119, Nov. 1920, pp. 595–600, 1 fig. Generalized form of fluid resistance met in case of blade screw.

Design. Screw Propellers, M. A. S. Riach. Aeronautics, vol. 19, nos. 368, 370, 371 and 372, Nov. 4, 18, 25 and Dec. 2, 1920, pp. 327–328, 362–365, 377–378 and 401–402, 6 figs. Nov. 4: Design formulas. Nov. 18: Equations of motion. Nov. 25: Formulas for determining stresses. Dec. 2: Relation between "momentum" and "aerofoil" theories of propeller, assuming "inflow" as theory basis. (Continuation of serial.)

Variable-Pitch. The Oddy Variable Pitch and Reversing Propeller, A. M. Buckwald. Aerial Age, vol. 12, no. 11, Nov. 22, 1920, p. 299, 1 fig. Propeller exhibited at London Aero Show.

Variable-Pitch Propeller for Flying at High Altitudes (Hélices à pas variable pour le vol aux grandes altitudes), J. Stroescu et D. Cusmanovici. Aérophile, vol. 28, nos. 17–18, Sept. 1–15, 1920, pp. 272–273, 4 figs. Patented design.

AEROPLANES

Aerofoils. The Wragg Adjustable Compound Aerofoil, C. A. Wragg. Aerial Age, vol. 12, no. 13, Dec. 6, 1920, p. 346, 2 figs. Device for enabling wider speed variation. It consists of using two aerofoils suitable for very high speed and placing them at low incidence, one behind and a little below the other so that there is a small gap between them.

Avro "Baby." Two-Seater Avro "Baby" Biplane, Type 543. Flight, vol. 12, no. 45, Nov. 4, 1920, pp. 1145–1147, 6 figs. Also Aeronautics, vol. 19, no. 368, Nov. 4, 1920, p. 326, 2 figs. Dimensions: Span of top plane 25 ft. Span of bottom plane, 23 ft.; gap between planes, 4 ft. 3 in.; length overall, 20 ft.; height overall, 7 ft. 6 in.; area of planes and ailerons, $176^1/_2$ sq. ft.; weight loaded, 970 lb.; maximum speed sea level, 82 m.p.h.; cruising speed at 1000 ft., 70 m.p.h.

Balancing. A Method for Determining the Angular Setting of a Tail Plane to Give Balance at any Given Condition, L. V. Kerber and W. F. Gerhardt. Aerial Age, vol. 12, no. 14, Dec. 13, 1920, pp. 370–373, 1 fig. Method includes determination of proper angular setting of horizontal tail plane to give longitudinal balance at level flight at any given speed, climbing flight at best rate of climb and when gliding at any angle with power off.

Bischoff. The Bischoff Small Aeroplane (L'avionnette de Pischoff), R. Esnault-Pelterie. Aerophile, vol. 28, nos. 17–18, Sept. 1–15, 1920, pp. 266–268, 2 figs. Dimensions: Length, 3.52 m.; height, 1.3 m.; width, 5.2 m.; total weight, empty, 102 kgr.; speed, 90 kw. per hr.

Centering. Centering Aeroplanes (Centrage des Avions), L. Huguet. Vie Technique et Industrielle, vol. 1, no. 9, June 1920, pp. 207–210, 6 figs. Influence of various elements of aeroplane upon its longitudinal stability in flight. (Continuation of serial.)

Design. Some Requirements of Modern Aircraft. Eng., vol. 110, no. 2864, Nov. 19, 1920, pp. 683–684, 6 figs. Requirements of aeroplanes for commercial aviation service.

Elevator Weight. The Effect of Elevator Weight, F. H. Norton. Aviation vol. 9, no. 14, Dec. 20, 1920, pp. 458–459, 3 figs. Effect of stability and controlability of elevator weight.

F.I.A.T. The F.I.A.T. Twelve-Seater Biplane. Flight, vol. 12, no. 47, Nov. 18, 1920, pp. 1189–1191, 6 figs. Characteristics: Span, top plane, 68 ft. 10 in.; span, lower plane, 69 ft. 9 in.; chord, 10 ft. 6 in.; overall length, 43 ft. 9 in.; overall height, 14 ft. 9 in.; weight, loaded, 11,000 lb.; speed range, 50–125 m.p.h.; ceiling full load, 15,000 ft.

Figure of Merit. A Figure of Merit for Airplanes, Donald W. McIlhiney. Aviation, vol. 9, no. 8, Nov. 8, 1920, pp. 254–257, 2 figs. It is suggested to use as figure of merit, ratio of the product of weight per horsepower times velocity at 90 per cent maximum times pay load times range, to product of landing velocity times total weight.

Flying Boats. See FLYING BOATS.

Fokker. Fokker Commerical Airplanes. Aviation, vol. 9, no. 12, Dec. 6, 1920, pp. 385–386, 3 figs. Cantilever monoplane type. Specifications: Engine, 185 hp. B.M.W.; span overall, 56 ft. 3 in.; length overall, 37 ft. 10 in.; height, 12 ft.; weight, fully loaded, 4125 lb.

Giant. Post-War Types of Giant Aeroplanes (Les avions géants d'après-guerre), Jean-Abel Lefranc. Nature (Paris), no. 2430, Oct. 30, 1920, pp. 276–285, 2 figs. Survey of developments. (To be continued.)

Glenn L. Martin. The Glenn L. Martin Commercial Transport Biplane. Aviation, vol. 9, no. 13, Dec. 13, 1920, pp. 426–428, 2 figs. Also Aerial Age, vol. 12, no. 15, Dec. 20, 1920, pp. 392–394, 3 figs. Specifications: Span, overall, 74 ft. 2 in.; length, overall, 43 ft. $7^5/_{16}$ in.; height, overall, 15 ft. $6^3/_4$ in.; total weight 12,000 lb.; power plant, 2 Liberty 12-cylinder V-type engines; maximum speed 110 m.p.h.

Helicopters. See HELICOPTERS.

Hydroplanes. See HYDROPLANES.

Lincoln Standard Cruiser. The Lincoln Standard Cruiser. Aerial Age, vol. 12, no, 12, Nov. 29, 1920, pp. 319–321, 5 figs. Specifications: Length overall, 26 ft. 4 in.; span, 41 ft.; chord, 6 ft.; weight, total, 3150 lb.; motor, 220 hp. Hispano-Suiza; maximum Speed, 95 m.p.h.; range, 350 miles.

Loening. The Loening Special Monoplane. Aerial Age, vol. 12, no. 15, Dec. 20, 1920, pp. 394–395, 2 figs. Dimensions: Overall length, 24 ft. $2^1/_2$ in.; overall height, 6 ft. 7 in.; total weight, 1850 lb.

Metallic Construction. The Utilization of Metallic Structures in Aeroplanes (L'utilisation des profilés

NOTE.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

métalliques dans la construction des aéroplanes). Aéronautique, vol. 2, no. 14, July 1920, pp. 52-54, 19 figs. Metals used, types of structures and methods of joining.

Model, Experiments with. Some Experiments with Model Airplanes, Albert A. Merrill. Aviation, vol. 9, no. 11, Nov. 29, 1920, p. 349, 2 figs. Experiments made in Eiffel's laboratory and National Physical Laboratory in England to determine static stability in pitch for models with elevator set in various positions.

Nieuport. The Battle Plane Nieuport (Le monoplane de combat Nieuport 29 C-1). Aéronautique, vol. 2, no. 14, July 1920, pp. 61-65, 7 figs. Characteristics: Span, 9.80 m.; length, 6.65 m.; height, 2.56 m.; engine, Hispano-Suiza, 300 hp.

Nieuport London. The Nieuport "London" Night Bomber. Flight, vol. 12, no. 49, Dec. 2, 1920, pp. 1231-1239, 23 figs. Triplane designed and built by Nieuport & General Aircraft Co., Cricklewood, England. Characteristics: Length overall, 37 ft. 6 in.; span, 59 ft. 6 in.; height, 18 ft.; engines two 320 hp. A.B.C. "dragonfly" engines mounted between lower and middle plane.

Passenger. The Unusual in Passenger-Carrying Airplanes, Alfred Longville. Sci. Am., vol. 123, no. 25, Dec. 18, 1920, p. 609, 3 figs. Recent developments in Germany and Italy.

Ranges. A Study in Aeroplane Ranges and Useful Loads, J. G. Coffin. Flight, vol. 12, nos. 47 and 48, Nov. 18 and 25, 1920, pp. 1199-1201, 2 figs., and 1214-1216, 3 figs. Nov. 18: Theory of maximum range conditions. Nov. 25: Effect of wind on range calculations.

Single- vs. Twin-Engined. A Comparison of Single- and Twin-Engined Aeroplanes, R. M. Hill. Aeronautics, vol. 19, no. 368, Nov. 4, 1920, pp. 320-321. Comparison from pilot's point of view. (Concluded.) Paper read before Royal Aeronautical Society.

Skylark. The Skylark. Aviation, vol. 9, no. 8, Nov. 8, 1920, p. 267, 1 fig. Dimensions: Average length, 22 ft. 6 in.; height, 7 ft.; total weight, empty, 730 lb.; machine, three-cylinder, 60 hp., Lawrence air-cooled engine.

Spars. The Design of Spars with Offset Pin Joints, Harris Booth. Aeronautical Jl., vol. 24, no. 118, Oct. 1920, pp. 563-574. Stresses in bay of spar under different loads. Design formulas.

Sperry Messenger. The Sperry Messenger Airplane. Aviation, vol. 9, no. 9, Nov. 15, 1920, pp. 285-286, 5 figs. Specifications: Span, 20 ft.; length, 17 ft. 9 in.; height, 7 ft.; weight, empty, 581 lb.; high speed, 95 m.p.h.; climb in 10 min., 10,000 ft.

Sport. A German Sport Monoplane. Aviation, vol. 9, no. 12, Dec. 6, 1920, p. 391. Designed by Sablatnig Flugzeugbau Cie Specifications: Engine, 3 cylinder, 20 hp. air-cooled; weight, empty, 185 kg.; span, 8.40 m.; length, 5.30 m.; height, 2.20 m.; speed, 110 km. per hr.

Two American Sportplanes. Flight, vol. 12, no. 45, Nov. 4, 1920, pp. 1156, 2 figs. W.A.C.O. "Cootie" and U. S. Airplane Co.'s "L.C.7." Dimensions: "Cootie," overall span, 22 ft.; overall length, 16 ft.; total wing area, 85 sq. ft.; speed range, 35 to 65 m.p.h.; climb, 4000 ft. in 10 min. Dimensions of "L.C.7," span, 26 ft.; overall length, 20 ft. 1 in.; overall height, 6 ft. 8 in.; speed range, 26 to 85 m.p.h.

Stability. Aerodynamic Study of the Supporting Members of an Aeroplane (L'étude aérodynamique des organes sustentateurs d'avion), M. Rocca. Aéronautique, vol. 2, nos. 14 and 15, July and Aug. 1920, pp. 87-91, 3 figs., and 129-123, 8 figs. Prantl method as set forth in the German press.

Steam Turbine for. The Study of a Steam Turbine for Airplanes, Luigi Acvampora. Aviation, vol. 9, no. 8, Nov. 8, 1920, pp. 261-262. Possibilities of designing steam turbine for propeller aeroplane. Advantages of such system of propulsion over internal-combustion engine.

Testing Railway. The Aerial Testing Railway of the German Experimental Station for Aviation and Discussion of the Propeller Drive for Railroad Cars (Die Flugzeugprüfbahn der Deutschen Versuchsanstalt für Luftfahrt und über den Luftschraubenantrieb für Eisenbahnfahrzeuge), H. Bendemann. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 11, nos. 17 and 18, Sept. 15 and 30, 1920, pp. 245-252 and 261, 12 figs. Description of tower supporting aeroplane to be tested which is mounted on a heavy car truck and drawn by locomotive, by means of which the aeroplane can be moved with great speed through air. Notes on method and arrangement used for measuring air forces to which aeroplane is subjected according to magnitude, direction and position. Details of car designed for carrying out aerodynamic measurements, which is driven by a 240-hp. Maybach engine with direct-coupled propeller; points out its useful possibilities for gaging speed-measuring instruments, etc.

A Railway for Testing Full Size Airplanes. Aviation, vol. 9, no. 14, Dec. 20, 1920, pp. 455-457, 7 figs. Steel tower fastened on railway car truck carries aeroplanes on top. Engine pulls structure at full speed and rating of performance of aeroplane under conditions of test are taken. Mechanism was devised to substitute for wind-tunnel model testing. Paper read before German Aeronautical Society.

Tests. Static Tests of Aeroplanes (Essais statiques des avions), Paul Boccacio. Aéronautique, vol. 2, no. 17, Oct. 1920, pp. 190-195, 8 figs. Methods of procedure.

Tests in Flight and the Laws of Aerodynamics (Les essais en vol et les lois de l'aérodynamique), Ch. Robin. Aéronautique, no. 3, Mar. 1920, pp. 431-436, 12 figs. Equipment developed for conducting aeronautical research in an aeroplane in flight.

Transport. Proposed Transport Airplane. Aviation, vol. 9, no. 100, Nov. 22, 1920, p. 321, 1 fig. Dimensions: Span, 125 ft.; overall height, 19 ft.; length overall, 75 ft.; total area, 3864, sq. ft.; maximum speed, 130 m.p.h.; total weight, 18.5 tons.

Variable-Surface. A French Variable Wing. Aeronautics, vol. 19, no. 372, Dec. 2, 1920, p. 391, 3 figs. Gastambide-Levavasseur design.

Another New Wing. Aerial Age, vol. 12, no. 11, Nov. 22, 1920, p. 297, 2 figs. Developed by Levavasseur, inventor of Antoinette monoplane.

The New Variable Surface Airplane, H. M. Buckwald. Aviation, vol. 9, no. 10, Nov. 22, 1920, pp. 314-316, 6 figs. Levavasseur and Gastambide is a tractor biplane fitted with 250 hp. Salmson engine. Pilot can vary surface, while in flight, from 345 sq. ft. to 560 sq. ft., by sliding panels in the upper plane.

Wings. The New Handley Page Aeroplane Wing. Engr., vol. 130, no. 3383, Oct. 29, 1920, p. 421, 2 figs. Slotted wing form. In trial tests, slotted machines rose at sharper angle, climbed more quickly, alighted at much slower speed and pulled up in considerably shorter distance than ordinary type.

Why the Wing of Uniform Section May Survive, Douglas Shaw. Aeronautics, vol. 19, no. 370, Nov. 18, 1920, p. 359. Because of its comparatively low cost of production. It is besides aerodynamically justified and desirable, and is a sound engineering compromise.

See also Variable-Surface.

AIR BRAKES

Defects. Car Failures Caused by Improper Brake Maintenance, E. H. Wood. Official Proc. Car Foreman's Assn., vol. 16, no. 2, Nov. 1920, pp. 21-33 and (discussion) pp. 34-71, 7 figs. Classification and discussion of principal defects in brake apparatus that cause car failures.

Swedish National Railways. The New Pneumatic Brake for Freight Trains of the Swedish National Railways (Statens järnvägars nya godstagsbroms), Gustaf Rydberg. Teknik Tidskrift (Veckoupplagan), vol. 50, no. 40, Oct. 2, 1920, pp. 437-443, 11 figs. Points out that a one-chamber brake does not fulfil requirements of a freight-train pneumatic brake, and describes various improvements of which the Kunze-Knorr brake, a combination of the one- and two-chamber brake, is said to be the best, the braking effect being 60 per cent greater than with a one-chamber brake of corresponding size.

AIR COMPRESSORS

High-Pressure. High-Pressure Compressors (Hochdruckkompressoren), V. v. Haaren. Zeit. des Vereines deutscher Ingenieure, vol. 64, nos. 44 and 46, Oct. 30 and Nov. 13, 1920, pp. 901-906 and 959-962, 26 figs. Recent development of high-pressure compressors for recovery of oxygen and nitrogen from the air, for production of ammonia according to the Haber process, and for operation of compressed-air mine railways, etc. Notes on different types; selection and arrangement of stages; cylinders; valves; stuffing boxes; lubrication of cylinders; packings; 5-stage mine compressors; compressors for chemical industry; and vertical compressors for use on board ships.

Lubrication. Lubrication of Air Compressors, H. V. Conrad. Glass Industry, vol. 1, no. 2, Dec. 1920, pp. 41-43, 1 fig. Practice recommended by Compressed Air Society.

AIR-HOSE LINES

Couplers. Making Thor Quick-Action Air Line Couplers, J. V. Hunter. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 931-933, 10 figs. Machining operations used in producing couplers in large quantities.

AIRCRAFT CONSTRUCTION MATERIALS

Casein Glue. Failure of Casein Glue Joints in Ash Louis J. Bradford. Aerial Age, vol. 12, no. 13, Dec. 6, 1920, pp. 346-347, and 354, 4 figs. Results of tests showed that both casein and hide glues possess sufficient strength to break spruce. With ash, however, hide-glue joints showed over double strength of those made with casein glue.

Wire Cables. Wire Cables, Walter A. Scoble. Aeronautical Jl., vol. 24, no. 118, Oct. 1920, pp. 537-562, 3 figs. Tests on wire rope under tension, shock and vibration. Bearing of core diameter on strength of cables. Cables tested were of types used in aeronautics.

AIRSHIPS

Commercial. The Commercial Airship—Its Operation and Construction, Trevor Dawson. Flying, vol. 9, no. 11, Dec. 1920, pp. 665-673, 9 figs. Traffic possibilities of airships. Size of airship required. Development of mooring power. Possibilities of reducing cost of construction and operation.

German. The German Airships L 64 and L 71. Automobile Engr., vol. 10, no. 144, Nov. 1920, pp. 445-447, 6 figs. Notes on their machinery installations.

Hangars. See HANGARS.

Wiring of. The Transverse Wiring of the Rigid Airship, E. H. Lewitt. Aeronautics, vol. 19, no. 372, Dec. 2, 1920, pp. 397-400, 6 figs. Theoretical investigation into magnitude and variation of tensions in transverse wires of rigid airship caused by pressure of adjoining gas bag.

ALCOHOL

See AUTOMOBILE FUELS, Alcohol.

ALLOY STEELS

Analysis. The Analysis of Special Steels, C. O Bannister. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 535-538, 5 figs. Use of electrometric titration methods.

Comparative Efficiency. A Suggested Method for Determining the Comparative Efficiency of Certain Combinations of Alloys in Steel, J. D. Cutter. Trans. Am. Soc. for Steel Treating, vol. 1, no. 3, Dec. 1920, pp. 188-190 and (discussion) pp. 190-3, 198, 7 figs. Formula for merit index is given. Efficiency is defined as ratio of effect produced to energy expended.

Effect of High Temperature. Comparative Values of Motor Valve Steels, G. Gabriel. Iron Age, vol. 106, no. 23, Dec. 2, 1920, pp. 1465-1469, 1 fig. Analysis of effects of high temperature on physical properties of tungsten, chrome and nickel steels. Translated from La Technique Automobile et Aérienne.

ALLOYS

Nickel-Chromium. See NICKEL-CHROMIUM ALLOYS.

ALUMINUM

Casting Losses. Analyze Loss in Aluminum Shops—I, Robert J. Anderson. Foundry, vol. 48, no. 24, Dec. 15, 1920, pp. 989-992. Replies to questionnaires on casting losses are analyzed and study is made of causes for and prevention of defects in castings. Enumeration of principal typical faults.

APPRENTICES, TRAINING OF

Prussian-Hessian State Railways. The Training of Fitter-Apprentices in the Workshops of the Prussian-Hessian State Railways, W. J. Horne. So. African Jl. of Sci., vol. 16, no. 5, April-July 1920, pp. 411-425. List of practical exercises at training workshops for apprentices.

Systems. Programs of Apprenticeship and Special Training in Representative Corporations—V, J. V. L. Morris. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 951-952, 4 figs. System of training machinists used in plant of Sperry Gyroscope Co., Brooklyn, N. Y.

Programs of Apprenticeship and Special Training in Representative Corporations, J. V. L. Morris. Am. Mach., vol. 53, no. 24, Dec. 9, 1920, pp. 1078-1080, 5 figs. Apprenticeship system of De La Vergne Machine Co., New York.

ASH HANDLING

German Power Plants. Ash Removal in Large Power Plants (Die Aschenbeseitigung in Grosskraftwerken), Ph. Scholtes. Elektrische Kraftbetriebe u. Bahnen, vol. 18, no. 26, Sept. 14, 1920, pp. 217-222, 13 figs. on supp. plate. Review of previous literature and summary of replies to a circular letter to large power plants in Germany; critical comparison of the different systems; practice at the Franken central station at Nuremburg; requirements of an ash-removal plant and list of firms engaged in their construction.

AUTOMOBILE ENGINES

Air Cooling. The Position of Air-Cooling, B. H. Davies. Autocar, vol. 45, no. 1310, Nov. 27, 1920, pp. 1055-1058, 12 figs. Review of present situation and possible lines of development.

British Designs. Tendencies in British Engine Design Noted at Olympia, M. W. Bourdon. Automotive Industries, vol. 43, no. 22, Nov. 25, 1920, pp. 1060-1065 and 1067, 18 figs. Most notable type observed by writer was carefully designed, small-powered car. (To be continued.)

Hot-Spot. Comparative Tests with a Hot-Spot Device, Roy E. Berg. Automobile Industries, vol. 43, no. 24, Dec. 9, 1920, pp. 1170-1173, 5 figs. Dynamometer tests made in engine laboratory of Lewis Institute showed appreciable fuel economy over wide range speed, smoother low speed, throttle operation and reduced crankcase dilution with Losee hot-spot device fitted to six-cylinder engine.

Properly Applied Heat—An Answer to the Fuel Question, Roy E. Berg. Motor Age, vol. 38, no. 20, Nov. 11, 1920, pp. 7-10, 9 figs. Tests on six-cylinder engine fitted without and then with hot-spot of replacement type.

Manufacture. Building Motors on the Pacific Coast, Fred. H. Colvin. Am. Mach., vol. 53, no. 43, Dec. 16, 1920, pp. 1117-1121, 24 figs. Methods at works of Hall-Scott Motor Car Co.

Machining Operations on the Nash Motor. Machy. (Lond.), vol. 17, no. 424, Nov. 11, pp. 171-174, 8 figs. Use of special machines and methods of equipping standard machine tools.

Nash. Nash Engine is Adapted to Four-Cylinder Practice, Roy E. Berg. Automotive Industries, vol. 43, no. 22, Nov. 25, 1920, pp. 1055-1058, 5 figs. New product closely follows six-cylinder features with latest combustion refinements. Lubrication of power plant is through positively driven gear pump. Chassis of 112-in.-wheelbase is employed for four models of cars on 1921 program. New constructional features described.

Radiators. Automotive Radiators, Karl F. Walker. Jl. Soc. Automotive Engrs., vol. 7, no. 6, Dec. 1920, pp. 549-553, 6 figs. Curves showing relation between core depth and heat-dissipating capacity, and effect of water flow on heat-dissipating capacity.

Ricardo Crosshead Piston. The 150 H.P. Ricardo Crosshead Piston Engines, S. Findlater. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 490-491, 2 figs. Notes on their performance on test in tanks.

AUTOMOBILE FUELS

Alcohol. A New Motor Spirit, C. F. Juritz. So-African Jl. of Industries, vol. 3, no. 10, Oct. 1920, pp. 889-894. Introduction of new solvent.

Alcohol and Motive Power (L'alcool et la force motrice), Albert Ranc and Jacques Boisseau. Nature (Paris), no. 2429, Oct. 23, 1920, pp. 260-263. Survey of studies made to determine applicability of alcohol as automobile fuel.

Researches on Alcohol as an Engine Fuel, Harold B. Dixon. Jl. Soc. Automotive Engrs., vol. 7, no. 6, Dec. 1920, pp. 521-524. It was found that alcohol possesses most of properties required in engine fuel. As compared with gasoline its lower calorific value is claimed to be compensated by greater compression at which it can be used and this property of high ignition temperature under compression is hardly altered by admixture with 20 per cent benzine or gasoline itself. (Abstract.) Report to Fuels Section of Imperial Motor Transport Conference, London.

Benzol-Alcohol Mixtures. Benzol-Alcohol Experiments on Omnibuses, G. J. Shave. Eng., vol. 110, no. 2862, Nov. 5, 1920, pp. 623-624. Fuel experiments carried out by London General Omnibus Co. Paper read before Imperial Motor Transport Council, London.

Gasoline. See GASOLINE.

Mixtures. Fuel Mixtures on London Omnibuses, G. J. Shave. Jl. Soc. Automotive Engrs., vol. 7, no. 6, Dec. 1920, pp. 556-557. Experiments carried out with a view to ascertaining most suitable mixture of benzol-alcohol for use in standard buses. Mixture of composition, alcohol 65 per cent, benzol 30 per cent and ether 5 per cent, has given satisfactory results with water-jacketed intake pipe. (Abstract.) Paper read before Fuels Section of Imperial Motor Transport Conference, London.

Petroleum. Use of Petroleum in Automobile Engines (Petroleumbetrieb), H. Praetorius. Motorwagen, vol. 23, no. 25, Sept. 10, 1920, pp. 465-472, 11 figs. Account of examination, by the Technical Commission of Automobile Club of France in collaboration with Gen. Automobile Assn. and Syndical Chamber of Petroleum Industries, of the Aldo, the Genault and the Bellem & Brégéras carburetors; and details of the Egtal pump, with which test was made using mixture of 40 per cent benzine and 60 per cent petroleum in engine of 4-cylinder automobile of latest construction with 80 mm. bore and 130 mm. stroke, and with 1800 revolutions an output of 30 hp. was achieved with fuel consumption of 270 gr. per hp-hr.

AUTOMOBILES

Bignan-Sport. The Refined Bignan-Sport, W. F. Bradley. Automotive Industries, vol. 43, no. 20, Nov. 11, 1920, pp. 956-958, 5 figs. Details of automobile of French production exhibited at Olympia Show, London. Lubrication of engine is under pressure and each bearing is fitted with oil collector which returns excess oil to base chamber. It is declared that oil consumption is only at rate of one gallon for 3000 miles.

Body Design. New Ideas in the Construction of Automobile Bodies (Neue Gesichtspunkte bei der Konstrukion von Automobil-Karosserien), Max Buch. Motorwagen, vol. 23, no. 25, Sept. 10, 1920, pp. 463-465, 6 figs. Description of automobile body constructed by author, an open car which in less than a minute can easily be transformed into a completely closed limousine or sedan.

Differential Casings. Machining Worm-driven Differential Casings. Eng. Production, vol. 1, no. 13, Dec. 1920, pp. 477-482, 17 figs. Description of methods employed.

Front-Axle Swivels. Front-Axle Swivels. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 478-479, 5 figs. Justification of vertical steering pivots.

Gear Ratio vs. Car Economy. Effect of Gear Ratio on Car Economy, J. N. Golten and Allan Neumann. Automotive Industries, vol. 43, no. 24, Dec. 9, 1920, pp. 1167-1169, 8 figs. Methods of obtaining best car performance with respect to fuel economy when using various gear ratios. Graphs and experimental data.

Locking Gear. The Goodheart Differential. Motor Traction, vol. 31, no. 818, Nov. 1, 1920, pp. 513-514, 4 figs. Automatic locking gear which eliminates wheel spinning.

Olympia Show. Public at London Show Interested in Economical Car, M. W. Bourdon. Automotive Industries, vol. 43, no. 20, Nov. 11, 1920, pp. 951-954, 8 figs. Few important engineering changes are reported in automobile exhibition recently held at Olympia, London.

The Automobile Show. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 486-489, 14 figs. Trend of design as shown by exhibits in International Exhibition at Olympia and White City.

Peugot. The 11 H.P. Peugot Chassis. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 482-485, 12 figs. Light French car with 10 hp. engine.

Transmission Case. Franklin Transmission Case, Fred. H. Colvin. Am. Mach., vol. 53, no. 22, Nov. 25, 1920, pp. 1001-1004, 10 figs. Machining operations.

AVIATION

Aerial Routes. Climatological Factors Governing the Selection of Air Routes and Flying Fields, C. LeRoy Meisinger. Aerial Age, vol. 12, no. 14, Dec. 13, 1920, pp. 368-369 and 373. Importance of meteorological studies in connection with the establishment of aerial routes and layouts of flying fields.

Canadian Air Board Report. Report of Canadian Air Board. Aviation, vol. 9, no. 8, Nov. 8, 1920, p. 264. Among matters considered are recent flight operations, Associate Air Research Committee; air navigation instructions for commercial fliers, and application of air regulations to civilians.

Civil. Civil Aviation. Aeronautical Jl., vol. 24, no. 119, Nov. 1920, pp. 579-590 and (discussion) pp. 590-594. Growth and present position of air mail, passenger and goods services, specially in United Kingdom and British Dominions and Colonies. Factors contributing to successful air services, and suggestions for their successful future development.

Civil Aviation and Air Services, F. H. Sykes. Flying, vol. 9, no. 11, Dec. 1920, pp. 674-679, 2 figs. Growth and present position of air mail, passenger and goods services. Factors contributing to successful air services.

The Organization of Civil Aviation Along International Lines, William Knight. Aerial Age, vol. 12, no. 13, Dec. 6, 1920, pp. 344-345. Urges creation of powerful organization that will establish and operate aerial lines of communication between most important centers of the world, and will take initiative in framing up legislation needed for governing navigation of air.

Commercial, German. Commercial Aviation in Germany. Aeronautics, vol. 19, no. 371, Nov. 25, 1920, pp. 375-376, 1 fig. Recent developments. Map of air routes established. (To be concluded.)

Course Determination. Route Correction—A New Method of Aerial Navigation (Correcteur de route; nouvelle méthode de navigation aérienne à l'estime), M. Le Prieur. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 16, Oct. 18, 1920, pp. 700-702. Aerial navigation by means of "derivograph," air apparatus which determines direction to be followed, corrected for wind, in order to reach a given place by straight line flight.

Hazards. Effective Study of Aviation Hazards Begun. Automotive Industries, vol. 43, no. 21, Nov. 18, 1920, pp. 1026-1027. Preliminary reports by Committee on Aviation Hazards of National Safety Council.

Mail Service. The Air Postman, H. S. Holt. Aeronautics, vol. 19, no. 370, Nov. 18, 1920, p. 360. Equipment required at terminal points. Organization of mail service.

Night Flying. Night Flying, Cecil Baker. Aeronautics, vol. 19, no. 368, Nov. 4, 1920, pp. 323-325. Experience during war. Problems of low flying, finding way, and landing.

Spins. Spins. Flight, vol. 12, no. 47, Nov. 18, 1920, pp. 1192-1195, 6 figs. How to describe a spin. Precautions to take. Stresses in aeroplane. Paper read before Cambridge University Aeronautical Society.

Switzerland. Aerial Navigation in Switzerland (La navigation aérienne en Suisse), E. H. Lémonon. Aerophile, vol. 28, nos. 17-18, Sept. 1-15, 1920, pp. 274-277, 2 figs. Development of aviation in Switzerland.

[See also FLIGHT.]

AXLES

Heat-Treating. Plant for Heat Treating Automobile Axles, L. M. Thomas. Am. Drop Forger, vol. 6, no. 11, Nov. 1920, pp. 533-536, 3 figs. Plant of Timken-Detroit Axle Co. Automatic annealing furnaces are used.

B

BALANCING

Slow-Speed vs. High-Speed. Slow-Speed vs. High-Speed Balancing, N. W. Akimoff. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 925-926, 1 fig. Balancing at low speeds is considered sufficiently conclusive, because if machine element cannot be balanced at such speeds, perfect balance will not be established at any speeds.

BLOWERS

Parallel Operation. The Operation of Blowers in Parallel for Forced Draft in Naval Service, M. C. Stuart and Arthur H. Sennet. Jl. Am. Soc. Naval Engrs., vol. 32, no. 4, Nov. 1920, pp. 688-718, 14 figs. Experimental investigation. It is concluded that fans operating in parallel should be run at the same speed because relatively small differences in speed cause an unequal division of load between fans in such a manner as to result in greater total shaft horsepower than would be required to produce same draft conditions with fans running at equal speeds.

BOILER FEEDWATER

Heating. The Mathematical Theory of Boiler Feedwater Heating in Steam Turbine-Driven Power Stations, Robert Dowson. Eng., vol. 110, nos. 2862 and 2863, Nov. 5 and 12, 1920, pp. 593-595, 4 figs., and 627-628. Nov. 5: Formula expressing total work lost by tapping off steam for feedwater heating. Nov. 12: Application of theory to design of group of surface feedwater heaters.

BOILERS

Construction. Examining a Steam Boiler Plant, Chas. F. Wade. Eng. & Indus. Management, vol. 5, no. 23, Dec. 2, 1920, pp. 706-710, 5 figs. Methods of construction and testing boilers. (To be continued.)

Largest in the World. The World's Largest Boilers. Power, vol. 52, no. 21, Nov. 23, 1920, pp. 828, 1 fig. Boilers being installed at Ford Plant at River Rouge, Mich. Boilers are of water-tube type and have effective heating surface of 26,470 sq. ft. each. Pulverized coal and blast-furnace gas will be burned at the same time by firing coal vertically from top and injecting gas horizontally through side.

Marine. See MARINE BOILERS.

Producer Gas-Fired. Producer Gas-Fired Boiler Installation in France, John H. Bartlett, Jr. Chem. and Metallurgical Eng., vol. 23, no. 21, Nov. 24, 1920, pp. 1033-1035, 5 figs. Description of installation and operation of producer gas-fired boiler plant at Montrambert, Loire, Coal Mines, using coked slack and mine waste for production of gas.

Rivet Steel. Standard Specifications for Boiler Rivet Steel. Boiler Maker, vol. 20, no. 12, Dec. 1920, pp. 354-355. Revised specifications of American Society for Testing Materials.

Waste-Heat. See FURNACES, OPEN-HEARTH, Waste-Heat Boilers.

BOILERS, WATER-TUBE

Ludlum. Construction of the Ludlum Watertube Boiler. Boiler Maker, vol. 20, no. 12, Dec. 1920, pp. 345-353 and 373-374, 17 figs. Methods developed by New York Engineering Company for reducing boiler production to machine-shop basis.

BRASS FOUNDING

Electric-Furnace. Electric Furnace Has Proved Value, Carl H. Booth. Foundry, vol. 48, no. 24, Dec. 15, 1920, pp. 994-997 and 1004, 5 figs. Simplicity of construction, great flexibility and comparatively low cost of operation are some of advantages claimed for rotating type of electric brass melting furnace. Paper read before American Foundrymen's Association.

BUILDING CONSTRUCTION

Cost Accounting. Practical Means of Estimating Equipment Cost. Contract Rec., vol. 34, no. 49, Dec. 8, 1920, pp. 1161-1163. Rental schedule prepared by Associated General Contractors of America, that aims to give adequate charges for use of contracting plant.

Costs. Building Material and Construction Costs—I, Theodore F. Laist. Am. Contractor, vol. 1, no. 22, Dec. 4, 1920, pp. 33-35. Study dealing with cost of building construction and of materials used in connection therewith. Brick is first material considered, being discussed under three heads, specifications, methods employed in quantity surveying and cost analysis.

Will Building Costs Come Down? Chas. F. Dingman. Concrete, vol. 17, no. 5, Nov. 1920, pp. 144-146. Writer does not expect building costs to be reduced materially within next year.

Equipment. Rental Schedule for Estimating Construction Equipment Expense. Eng. and Contracting, vol. 54, no. 24, Dec. 15, 1920, pp. 583-584. Rental Schedule for construction equipment.

Lightning Protection. Protection Against Lightning. Contract Rec., vol. 34, no. 47, Nov. 24, 1920, pp. 1132-1133. Procedure for rodding structures, based on practice in United States and Canada.

Office Buildings. Engineering Details of Newspaper Publishing Building, Charles F. Dingman. Eng. News-Rec., vol. 85, no. 23, Dec. 2, 1920, pp. 1092-1094, 4 figs. Building is of modified mill construction, basement and three stories in height and occupies entire area of plot 100 ft. square.

Railway Shops. Gypsum Tile as a Covering for Railroad Buildings, Curtis F. Columbia. Ry. Age, vol. 69, no. 23, Dec. 3, 1920, pp. 961-962, 3 figs. Principal characteristics of five large railway blacksmith shops.

C

CABLEWAYS

Design. Dedactic Study of Aerial Cableways (Étude didactique des transporteurs aériens sur câbles), Giulio Ceretti. Génie Civil, vol. 77, no. 21, Nov. 20, 1920, pp. 408-411, 7 figs. Characteristics of metallic cables. Notes on design. (To be continued.)

CAR COUPLERS

Universal. The Universal Car and Hose Coupler. Railroad Herald, vol. 24, no. 11, Oct. 1920, pp. 27-29, 4 figs. Features are: (1) Beveled engaging surfaces of coupler head, whereby "high and low" couplings are entirely removed; (2) locking or latch is always open and ready for use as soon as cars are uncoupled; (3) coil spring is held in groove or cavity, giving it snug fit; (4) one man can easily handle coupler shank; etc.

CARBURETORS

Automatic. Modern Automatic Carburetors for Volatile Fuels (Étude des carbureteurs automatiques modernes pour carburants volatils), A. Grebel. Génie Civil, vol. 77, no. 19, Nov. 6, 1920, pp. 370-375, 15 figs. Developments in design. (To be continued.)

Induction Systems. Induction Systems, T. L. Sherman. Automobile Engr., vol. 10, no. 144, Nov. 1920, pp. 433-439, 28 figs. Comparative study of induction type of carburetors of principal areoplane engines.

Tests. The German Carburetter Trials, J. L. Chaloner. Automobile Engr., vol. 10, no. 144, Nov. 1920, pp. 450-453, 15 figs. Account of trials carried out under control of General German Automobile Club.

CARS

Brakes. See AIR BRAKES.

CARS, FREIGHT

Steel Gondola. 50-Ton Steel General Service Car. Eng., vol. 110, no. 2862, Nov. 5, 1920, pp. 604-5

and pp. 608, 16 figs., partly on supp. plate. Gondola car constructed by Pressed Steel Car Co., Pittsburgh, for Russian Government.

CASE-HARDENING

Building for. Modern Case Hardening Building at Providence. Iron Age, vol. 106, no. 24, Dec. 9, 1920, pp. 1539–1540. Features include arrangements for maximum ventilation with minimum light and dipping and cooling tanks.

[See also CRANKSHAFTS, Case-Hardening.]

CAST IRON

Carbon in. On the Crystalline Nature of Graphite and Temper-Carbon Obtained from Cast Iron, Kei Iokibé. Sci. Reports of the Tôhoku Imperial University, vol. 9, no. 4, Aug. 1920, pp. 275–279, 4 figs on supp. plate. It is concluded from investigation that the so-called graphite carbon and the temper carbon, as found in cast iron, are both the same substance as natural graphite, and since condition of decomposition of cementite is same for both steel and cast iron, the temper carbon from carbon steels will also be graphite, and not an amorphous carbon.

Influence of Nickel and Cobalt. The Influence of Nickel and Cobalt Additions on the Physical and Chemical Properties of Cast-Iron, O. Bauer and E. Piwowarsky. Foundry Trade Jl., vol. 22, no. 228, Dec. 1920, pp. 936–937. Melting experiments with cast-iron with nickel and cobalt additions.

Sulphur in. The Sulphur Problem in Cast Iron, George K. Elliott. Foundry, vol. 49, no. 24, Dec. 15, 1920, pp. 978–979. Basic electric furnace said to produce sulphur far below 0.05 per cent. Paper read before American Foundrymen's Association.

CEMENT, PORTLAND

Testing. Japanese Standard Rules for Testing Portland Cement. Cement, Mill and Quarry, vol. 17, no. 10, Nov. 20, 1920, pp. 37–38. Issued by Department of Agriculture and Commerce on Feb. 10, 1905, revised Dec. 10, 1909 and June 20, 1919. Translated by Japan Portland Cement Association.

CENTRAL STATIONS

Economics. Central-Station Costs and Income. Elec. World, vol. 76, no. 22, Nov. 27, 1920, pp. 1067–1068, 4 figs. Tendencies that appear under present conditions. Vigorous efforts are apparent to increase plant efficiency and render larger service in face of higher costs. Larger revenue helping to meet unusual requirements.

South America. Power Development in New World and Asia, L. W. Alwyn-Schmidt. Power Plant Eng., vol. 24, no. 23, Dec. 1, 1920, pp. 1113–1115. Prospects for central station. Power development in South America.

COAL

Calorific Value. Economic Value of Coal—II. Calorific Value and Relative Plant Economy with Coal as Fuel, B. S. Murphy. Power, vol. 52, no. 24, Dec. 14, 1920, pp. 936–937, 1 fig. Laboratory tests of coal.

COAL HANDLING

Bucket Cars. How Coal is Handled in South Africa. Coal Age, vol. 18, no. 24, Dec. 9, 1920, pp. 1178–1179, 3 figs. Coal is loaded into ten-ton buckets which are lifted by crane on to specially fitted car. At receiving station bucket can be removed by crane.

Central Stations. The West Penn Power Company's New Coal-Handling System. Nat. Elec. Light Assn. Bull., vol. 7, no. 12, Dec. 1920, pp. 874–875, 1 fig. Plant will elevate, screen, pick, crush, weigh and convey to bunkers of boiler-room 500 tons of coal an hour.

Motor Trucks. Youghiogheny Coal Co. Delivers 60,000 Tons Monthly by Motor Trucks, Donald J. Baker. Coal Age, vol. 18, no. 25, Dec. 16, 1920, pp. 1234–1238, 4 figs. It costs 17.5c to move one ton of coal one mile, $3.53 to operate six-ton truck one hour, and total yearly saving made by trucks over horse-drawn wagons handling same tonnage amounts to about $43,000.

COAL STORAGE

Piling. Piling Storage Coal to Prevent Fire, W. D. Langtry. Power, vol. 52, no. 21, Nov. 23, 1920, pp. 815–817, 7 figs. Suggestions in regard to choosing suitable place, avoidance of breakage in unloading, segregation of different sizes, outside sources of heat and mixing of combustible matter with coal.

COKE OVENS

By-Product. Modern By-Product Oven Operation, C. R. Bellamy. Gas Age, vol. 46, no. 9, Nov. 10, 1920, pp. 340–342, 4 figs. Results obtained by ovens built at Detroit, Mich., for Ford Co.

COMBUSTION

Air Supply. Air for Combustion. Power, vol. 52, no. 24, Dec. 14, 1920, p. 952, 2 figs. Chart showing pounds of air required per boiler horsepower, boiler and furnace efficiency and per cent excess air being given.

CONCRETE

Aggregates. The Strength of Fine-Aggregate Concrete, F. E. Giesecke, H. R. Thomas and G. A. Parkinson. Univ. of Texas Bul., no. 1855, Oct. 1, 1918, 17 pp., 5 figs. Experiments made to determine how compressive strength of concrete varies with relative quantity of cement when the maximum size of aggregate used in preparation of concrete is considerably smaller than that usually employed in concrete construction. Good concrete was prepared without use of coarse aggregate. It was found as general rule that to obtain concrete of given strength with given materials relative quantity of cement must be increased as maximum size of aggregate is decreased.

Crusher Screenings for. Crusher Screenings Make Stronger Concrete. Contract Rec., vol. 34, no. 48, Dec. 1, 1920, pp. 1138–1141. Tests made for Canadian Crushed Stone Corp'n.

Hydrated Lime, Effect of. Effect of Hydrated Lime in Concrete, Duff A. Abrams. Contract Rec., vol. 34, no. 50, Dec. 15, 1920, pp. 1183–1186. Answers to criticisms (see Contract Record, Nov. 24, 1920) of writer's original report which was based on researches regarding effect of various admixtures in concrete. Original paper was read before American Society for Testing Materials.

Proportioning. Proportioning Concrete Aggregates When Unscreened or Pit Run Gravel is Used, L. A. Doan. Eng. & Contracting, vol. 54, no. 22, Dec. 1, 1920, p. 534, 2 figs. Graphs for determining proportions of aggregates.

Recent Developments in Concrete Mixtures, H. C. Boyden. Ry. Rev., vol. 67, no. 21, Nov. 20, 1920, pp. 778–783, 7 figs. Graphs showing relations between strength of concrete and water content, relation between fineness, modulus of aggregate and strength of concrete, diagram for determining quantity of sand required in concrete mixers, and Abram's table of proportions and quantities for one cubic yard of concrete.

Tests. Pouring and Pressure Tests of Concrete, W. A. Slater and A. T. Goldbeck. Technologic Papers of Bur. of Standards, no. 175, Oct. 11, 1920, 13 pp., 4 figs. Maximum pressure against forms during pouring of concrete was found to be equivalent to that of liquid weighing about 124 lb. per cu. ft. Maximum pressure was found to be that due to head of concrete existing at end of about 40 min. After that time pressure gradually decreased in spite of increasing head of concrete.

Ten-Year Tests Showing the Effect of Age and Curing Conditions on the Strength of Concrete, M. O. Withey: Wisconsin Engr., vol. 25, no. 2, Nov. 1920, pp. 19–21, 2 figs. It is concluded that humidity of surrounding medium in which portland cement concrete is cured exercises marked effect upon its crushing strength. It was found that portland cement could be kept without deteriorating for several years when stored in tight tanks, or cylindrical galvanized-iron grain bins.

CONCRETE CONSTRUCTION

New System. A New System of Concrete Construction Making Use of Standard Wood Forms. Building Age, vol. 42, no. 12, Dec. 1920, pp. 23–25, 5 figs. Wooden permanent forms developed and patented by Samuel S. Colt.

Slabs. Diagram for Flat Slabs, O. Wolpert. Concrete, vol. 17, no. 5, Nov. 1920, pp. 142–143, 1 fig. Diagram for estimating quantity of steel and total thickness of slab required for square interior flat slabs, with drop panels, based on regulations of City of New York.

Reinforced Concrete Design Standards, C. A. P. Turner. Concrete, vol. 17, no. 5, Nov. 1920, pp. 152–155, 6 figs. Standards proposed by several associations which are criticized on basis that their reasoning is not verified by experimental evidence. It is emphasized that mathematical theory to be acceptable should be substantiated by experiment.

Reinforced Concrete Saw-Tooth Slab Design, J. W. Pearl. Concrete, vol. 17, no. 5, Nov. 1920, pp. 163–164, 2 figs. Chart for designing slabs.

Safe Loads and Deflections for "Gunite" Slabs. Can. Engr., vol. 39, no. 21, Nov. 18, 1920, pp. 525–529, 10 figs. Tests on 43 slabs at Lehigh University disclose high flexural strength, bending stress of 1800 lb. per sq. in. on 1:2½ gunite with factor of safety of 4. Deflections were less than those for poured slabs. Reinforcement tables run up as results of experiments are included.

Standards. Proposals for New Standards for Concrete and Reinforced Concrete Construction (Entwürfe neuer Normblätter). Beton u. Eisen, vol. 19, no. 15, Sept. 20, 1920, pp. 174–180, 9 figs. Proposed standards of the German Industry Committee on Standards for cable conduits, concrete slabs for walls: holding capacity of concrete mixing machines (grinding mill and drum mixers); railway ties and coping stones of natural stone and of concrete; concrete flagstones.

Subaqueous. Experiences in Subaqueous Concrete Work, Henry R. Lordly. Cornell Civil Engr., vol. 28, no. 6, March 1920, pp. 254–263, 4 figs. Successful instances of placing concrete under water are related. It is held there is no further need of building expensive cofferdams.

CONCRETE, REINFORCED

Wood Reinforcement. Reinforcing Concrete with Wood (Le béton armé de bois). Génie Civil, vol. 77, no. 20, Nov. 13, 1920, pp. 394–396, 8 figs. Methods of reinforcing developed in experiments.

CONDENSERS, STEAM

Selection. Application of Steam Condensers, F. A. Burg. Elec. Jl., vol. 17, no. 12, Dec. 1920, pp. 583–587, 6 figs. Factors bearing on selection of type of condenser.

Surface. Surface Condensers, Luther D. Lovekin. Twenty-eighth General Meeting, Soc. Naval Architects & Mar. Engrs., Nov. 11 and 12, 1920, no. 7, 5 pp., 10 figs. Progress in design of surface condensers as applied to power plants in U. S. Navy Ships.

CONVEYORS

Cable. The Roe Cable Conveyor, George Frederick Zimmer. Eng., vol. 110, no. 2864, Nov. 19, 1920, pp. 665–667, 37 figs. partly on supp. plate. Wire rope conveyor for medium distances, designed by J. Pearce Roe.

Combined Skip Hoist and Conveyor. Combined Skip-Hoist Elevator and Conveyor, George Frederick Zimmer. Eng. and Indus. Management, vol. 4, no. 19, Nov. 4, 1920, pp. 597–598, 5 figs. Device patented by Warren Travell, of Exeter Machine Works, New York City. It combines skip hoist with band conveyor and with tipping trolley on wheels.

Pneumatic. Pneumatic Conveyors of Fine Materials. Contract Rec., vol. 34, no. 51, Dec. 22, 1920, pp. 1218–1220. Examples of English installations for the pneumatic lifting and conveying of coal and other materials.

CORE OVENS

Electrically Heated. Core Baking in Electrically Heated Ovens, J. L. Jones. Iron Age, vol. 106, no. 22, Nov. 25, 1920, pp. 1385–1387, 3 figs. Results of comparative tests of electric and fuel heated core ovens. New Westinghouse thermostat control.

Electrifying the Foundry Core Room, J. L. Jones. Elec. World, vol. 76, no. 25, Dec. 18, 1920, pp. 1203–1204, 3 figs. Cores baked in electrically heated ovens shown to have 50 to 200 per cent greater strength than those baked in fuel-fired ovens.

CORK

Substitute for. A Substitute for Cork. Commerce Reports, no. 283, Dec. 2, 1920, p. 978. Turf treaded by special patented process developed by chemical works at Bruenn-Koenigsfeld, Prague.

CORROSION

Iron and Steel. Experiments on the Corrosion of Iron and Steel, William D. Richardson. Can. Chem. Jl., vol. 4, no. 11, Nov. 1920, pp. 299–307. Passivity of iron as oxidation phenomenon. (Concluded.)

COST ACCOUNTING

Factory. Factory Costs, L. T. Konopak. Jl. of Accountancy, vol. 30, no. 5, Nov. 1920, pp. 329–337. Describes cost system designed for factory manufacturing transmissions, and forms provided for reporting the various transactions of factory designed to facilitate handling clerical work in a routine manner with least consumption of time.

COSTS

Relation to Selling Prices. The Determination of Costs and Their Relation to Profit and Selling Prices. Eng. & Indus. Management, vol. 4, no. 23, Dec. 2, 1920, pp. 713–715. Predetermination of prices.

CRANES

Floating. Two-Hundred Ton Mammoth Floating Crane at Gusto Shipyard, Schiedam, Holland [Grue Flottante "Mammoth," de 200 tonnes, des Chantiers Gusto, de Schiedam (Hollande)]. Génie Civil, vol. 77, no. 19, Nov. 6, 1920, pp. 365–367, 3 figs. Crane can lift 200 tons 52 m. high above surface of water. Radius of action is 34 m.

CRANKSHAFTS

Case-Hardening. Case-Hardening Process for Crankshafts Successfully Developed, Norman G. Shidle. Automotive Industries, vol. 43, no. 21, Nov. 18, 1920, pp. 1016–1019, 5 figs. Process developed from tests made by H. H. Franklin Manufacturing Co.

CRIPPLES

Artificial Limbs. The Muscular Strength in an Amputated Arm and Its Utilization (Die Muskelkräfte im Innern des amputierten Armes und ihre Nutzbarmachung), G. Schlesinger and K. Meyer. Werkstattstechnik, vol. 14, no. 17, Sept. 1, 1920, pp. 457–463, 24 figs. Results of experiments carried out at the Charlottenburg Testing Inst. for Substitute Limbs. Abstract of report of investigations of about 30 men who had undergone the Sauerbruch operation, and of a large number of artificial hands and arms with apparatus especially constructed therefore, description and illustrations of which are given.

CUPOLAS

Charges, Determining. Method for Determining Cupola Charges, H. L. Campbell. Foundry Trade Jl., vol. 22, no. 227, Nov. 1920, pp. 856–857, 1 fig. Chart for determining mixtures.

CYLINDERS

Automobile Engines. How Cylinders are Made in England, H. Cole Estep. Foundry, vol. 48, no. 23, Dec. 1, 1920, pp. 933–939, 13 figs. Standardization of operations and extensive use of molding machines have aided quantity production.

D

DIES

Double-Flanged Shell. Dies for Double-Flanged Shell, J. Bingham. Machy. (Lond.), vol. 17, no. 424, Nov. 11, 1920, pp. 176–178, 10 figs. Procedure for designing drawing dies.

DIESEL ENGINES

Busch-Sulzer. Diesel Engines in a Modern Flour Mill. Power, vol. 52, no. 21, Nov. 23, 1920, pp. 808–810, 5 figs. Busch-Sulzer and Fulton-Tosi types used.

Fuel Injection. Air-Injection or Mechanical-Injection, J. L. Chaloner. Motorship, vol. 5, no. 12, Dec. 1920, pp. 1084–1085, 8 figs. Technical study of fuel injection in Diesel engines. (To be continued.)

Some Experiments in Connection with the Injection and Combustion of Fuel Oil in Diesel Engines, C. J. Hawkes. Trans. North-East Coast Instn. Engrs. & Shipbuilders, advance paper, 44 pp., 28 figs. Experiments carried out at British Admiralty Engineering Laboratory in connection with development of high-speed engine for naval purposes. Both solid-injection and air-injection systems were taken up.

Marine. Building Diesel Marine Engines for Merchant Vessels—I, Fred B. Jacobs. Mar. Rev., vol. 50, no. 12, Dec. 1920, pp. 640–647, 12 figs. Manufacturing methods at Busch-Sulzer Bros.-Diesel Engine Co., St. Louis.

Opposed-Piston. British Admiralty Experiments with Diesel Engines—III, C. J. Hawkes. Motorship, vol. 5, no. 12, Dec. 1920, pp. 1086, 3 figs. Tests on Doxford opposed-piston submarine Diesel engine. (Concluded.)

DRILLING

Automobile Plants. Multiple Drilling in Automobile Plants. Machy. (Lond.), vol. 17, no. 426, Nov. 25, 1920, pp. 225–229, 10 figs. Multiple-spindle drilling machines.

Deep-Hole. Some Experiences in Deep-Hole Drilling, Charles J. Starr. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1023–1026, 9 figs. Requirements of Drill.

DRILLING MACHINES

Multiple-Spindle. A Multiple Spindle Drilling Machine, G. L. Bohannon. Boiler Maker, vol. 20, no. 11, Nov. 1920, pp. 321–323, 5 figs. Machine built by Thomas Spacing Machine Co., Pittsburgh, Pa. Chief feature is chain drive which gives direct pull on spindles and is said to eliminate power losses.

Semi-Automatic. A New Type of Semi-Automatic Drilling Machine. Machy. (Lond.), vol. 17, no. 423, Nov. 4, 1920, pp. 139–140, 5 figs. Drill is fed to work by automatic cam motion. Feature is tilting work table whereon two work-holding fixtures may be mounted, each being brought under drill spindle in turn. Machine is manufactured by S. Ratcliffe, Ltd., Manchester, England.

Universal. 5-Ft. Universal Radial Drilling Machine. Eng., vol. 110, no. 2862, Nov. 5, 1920, pp. 600–601, 6 figs. Arm can be swiveled for angle drilling and spindle swiveled on saddle. Manufactured by Niles-Bement-Pond Co., New York.

DRILLS

Electric. Portable Electric Tools, Machy. (Lond.), vol. 17, no. 427, Dec. 2, 1920, pp. 250–252, 7 figs. Electric drills.

Twist. Proper Care of Twist Drills as a Means of Economy, G. P. Blackiston. Boiler Maker, vol. 20, no. 12, Dec. 1920, pp. 360–361. Tables showing speeds and feeds for carbon and high-speed drills.

DROP FORGING

English Plant. A Modern Drop Forging Plant. Eng. Production, vol. 1, no. 13, Dec. 1920, pp. 483–486, 8 figs. Description of Abbey Works Forge of Clayton & Shuttleworth, Lincoln, England.

Practice. Drop Forging, J. H. Moore. Can. Machy., vol. 24, no. 23, Dec. 2, 1920, pp. 485–489, 9 figs. Examples of drop-forging practice, including axles and crankshafts.

DYE HOUSES

Organization and Construction. Organization and Construction of Dye Houses, A. W. Benoit. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 673–674 and p. 706, 2 figs. Machinery organization, location, construction, ventilation and piping of dye houses considered from engineering viewpoint.

DYNAMOMETERS

Farm Tractors. National Physical Laboratory Traction Dynamometer for Agricultural Tractors, J. H. Hyde. Eng., vol. 110, no. 2865, Nov. 26, 1920, pp. 693–694, 7 figs. Apparatus consists of cylinder and plunger, former being attached to drawbar of tractor, and latter through links to plow. Pull on coupling sets up pressure in oil confined in cylinder, at flexible hydraulic tube.

E

EDUCATION, INDUSTRIAL

Ford Institute of Technology. Linking Education With Factory Costs—III, T. P. Hickey. Factory, vol. 25, no. 11, Dec. 1, 1920, pp. 1726–1730, 8 figs. Organization of Ford Inst. of Technology.

ELECTRIC DRIVE

See ICE PLANTS, Electrically Driven; ROLLING MILLS, Electrically Driven.

ELECTRIC FURNACES

Booth. Booth Rotating Electric Brass Furnace, Carl H. Booth. Iron Age, vol. 106, no. 23, Dec. 2, 1920, pp. 1463–1464, 2 figs. Records recently made on 500 lb. rotating electric furnace at plant of Enterprise Brass Works, Muskegon, Mich. Paper read before Am. Foundrymen's Assn.

Combustion vs. Electric vs. Combustion Furnaces for Low Temperatures, Frank W. Brooke and George P. Mills. Chem. and Metallurgical Eng., vol. 23, Nov. 24, 1920, pp. 1008–1010. Electric furnaces are found to have advantage in temperature control, reliable and permanent source of heat and maintenance. Cost of power is counterbalanced by economy in space, auxiliaries, and operation, while quality of product is greatly enhanced.

Commercial Types. The Electric Melting Furnace, Joseph W. Richards, F. W. Brooke, R. D. Thomas, S. H. Ourbacker, G. H. Clamer. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 12, Dec. 1920, pp. 1034–1043, 16 figs. Structural details of principal commercial types.

Linings. Linings for Electric Furnaces, R. M. Howe. Iron Trade Rev., vol. 67, no. 23, Dec. 2, 1920, pp. 1541–1543. Survey is made of nine materials used as refractories for electric units. Physical characteristics compared. Fusion points are lowered by pressure. Silica and magnesia tend to spall.

Metal Industries, Use in. The Present Status of the Electric Furnace in the American Metal Industries, Robert M. Keeney. Chem. & Metallurgical Eng., vol. 23, no. 20, Nov. 17, 1920, pp. 980–984. Present technology and future possibilities of electric furnace as applied in manufacture of synthetic cast iron, steel, steel castings, ferroalloys and in heat treating, brass melting and smelting of non-ferrous ores. Paper read before Nat. Elec. Light Assn.

Motion of Liquid by "Motor Effect." Nature and Explanation of the "Motor Effect" in the Ajax-Wyatt Furnace, E. F. Northrup. Jl. Franklin Inst., vol. 190, no. 6, Dec. 1920, pp. 817–834, 4 figs. When high-tension current, direct or alternating, flows in a liquid conductor, motions of liquid of considerable magnitude are always produced. Article develops formula for calculating mechanical forces which arise by interaction of triangular circuit carrying current upon short section of circuit. Numerical results are tabulated and values of forces are given in chart.

Refractories for. Refractories For Electirc Furnaces, R. M. Rowe. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 911–913. Survey of different materials and tables of their physical characteristics. Paper read before Elec. Furnace Assn.

Repelling Arc. Electric Furnace with a Repelling Arc. Iron Age, vol. 106, no. 24, Dec. 9, 1920, pp. 1556–1557, 4 figs. Electric furnace for steel and non-ferrous operations developed by Industrial Electric Furnace Co., Chicago. When current flows electrodes are forced apart, thus drawing arc.

Steel Manufacture. English and American Types of Electric Iron and Steel Furnaces Compared, John B. C. Kershaw. Iron & Coal Trades Rev., vol. 101, no. 2750, Nov. 12, 1920, pp. 637–640 and 655–658, 16 figs. Based on records of operation at steel works.

ELECTRIC LAMPS, MERCURY-ARC

Cooper Hewitt. The Cooper Hewitt Quartz Lamp and Ultra-Violet Light, L. J. Buttolph. Gen. Elec. Rev., vol. 23, no. 11, Nov. 1920, pp. 909–916, 8 figs. Summary of latest developments of compilation of related technical data.

ELECTRIC LOCOMOTIVES

Driving Gears. Driving-Gear Arrangements in Electric Locomotives (Treibwerksanordungen bei elektrischen Lokomotiven), A. Marschall. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 43, no. 39, Sept. 24, 1920, pp. 299–302, 3 figs. Discussion of various types, including the Brown, Boveri & Cie and the Tschantz driving gear, but with special consideration of the latest Lentz construction, with which it is said to be possible to render gear ratio between motor- and driving-wheel shaft variable, as with automobile gears.

ELECTRIC WELDING

Development. Practical Applications of Electric Welding, F. P. Vaughan. Jl. Eng. Inst. Canada, vol. 3, no. 12, Dec. 1920, pp. 556–564, 5 figs. Survey of electric welding methods, resistance, carbon arc, metallic arc and quasi-arc; methods of application, tables of power consumption, etc.; training welder, protection devices.

Electropercussive. Recent Developments in Electro-Percussive Welding, Douglas F. Miner. Welding Engr., vol. 5, no. 11, Nov. 1920, pp. 27–28 and 32, 7 figs. Describes apparatus used, which consists essentially of device for producing a percussive engagement of parts to be welded, practically simultaneous with discharge of electrical energy. Gives examples of electropercussive welding and photomicrographs.

ELECTRIC WELDING, ARC

Overhead. Overhead Arc Welding—Theory and Practice, O. H. Eschholz. Power, vol. 52, no. 20, Nov. 16, 1920, 776–780, 11 figs. Also results of tensile tests made on sections cut from overhead welds.

EMPLOYMENT MANAGEMENT

Psychotechncal Tests. Apparatus for Adaptability Tests (Apparate fur Eignungsuntersuchungen), R. Thun. Betrieb, vol. 3, no. 1, Oct. 10, 1920, pp. 24–29, 7 figs. Gives certain guiding rules which should be taken into consideration in development of apparatus and describes various apparatus.

Psychotechnical Adaptability Tests (Psychotechnische Eignungsprüfungen), H. Heilandt. Betrieb, vol. 3, no. 1, Oct. 10, 1920, pp. 16–21, 12 figs. Describes method of examination employed in the admission of industrial apprentices in the works school of the German General Electric Co.'s factories in Berlin.

The Reliability of the Psychological Adaptability Tests (Bewährung der psychologischen Eignungsprüfungen), H. Rupp. Betrieb, vol. 3, no. 1, Oct. 10, 1920, pp. 1–8, 7 figs. It is shown that the reliability of an adaptability test can be accurately determined and what degree of reliability according to described method can be ascribed to the most important tests so far developed. Points out certain requirements which are necessary for the proper application and improvement and extension of tests.

Selecting Employees. The Scientific Selection of Men, Arthur Frank Payne. Sci. Monthly, vol. 2, no. 6, Dec. 1920, pp. 544–547. Experience with mental tests in army.

ENGINEERING SOCIETIES

Relationship to Public Service. Some Phases of Relationship of Engineering Societies to Public Service, Herbert Hoover. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 12, Dec. 1920, pp. 1073–1075. Address before Federated American Engineering Societies.

ENGINEERS

Registration. Report of Ontario Committee on Legislation. Can. Engr., vol. 39, no. 26, Dec. 23, 1920, pp. 631–635. Text of bill for official registration of engineers, proposed by Ontario Advisory Committee.

Remuneration. Manitoba Engineers Pledged to Salary Schedule. Can. Engr., vol. 39, no. 20, Nov. 11, 1920, pp. 505–508. Work being done by Remuneration Committee of Manitoba Branch, Engineering Institute of Canada, in enforcing Salary Committee's recommendations. Branch has decided that "any engineer who fails to receive salary adequate to his class as recommended by the Remuneration Committee will be assisted by the Engineering Institute of Canada to obtain other employment at adequate remuneration and will receive the moral, and, if necessary, financial support of all other engineers in the province." Classification of engineers and schedule of salaries prepared by Salary Committee are included.

ENGINEHOUSES

Electrical Equipment. Electrical Equipment of New Engine Terminal. Ry. Elec. Engr., vol. 11, no. 12, Dec. 1920, pp. 437–439, 4 figs. Motors used in machine shops and on turntable at terminal on New York Central at Minerva, Ohio.

F

FACTORIES

Layout. Economy of Horizontal Space by the Machine Layout. J. Edward Schipper. Automotive Industries, vol. 43, no. 20, Nov. 11, 1920, pp. 964–967, 6 figs. Description of Holley carburetor factory. Light work is arranged on continuous table with machines spaced by requirements of workmen.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT

FANS, CENTRIFUGAL

Design. The Design and Construction of Fans—I, F. G. Whipp. Mech. World, vol. 68, no. 1768, Nov. 19, 1920, pp. 354–355, 3 figs. Calculation of efficiencies of propeller fans.

FATIGUE

Industrial. An Experiment with Rest Pauses, J. Loveday. Eng. & Indus. Management, vol. 4, no. 23, Dec. 2, 1920, pp. 716–718. Experiment in British shoe factory. Double presses were worked with team of three girls each operative working 40 min. in each hour and resting 20 min. Output was increased from 57 to 75 per cent.

FLIGHT

Man-Power. The Problem of Flight with Man-Power (Das Problem des MS-Fluges), Rudolph Waschmann. Luftfahrt, vol. 24, no. 9, Sept. 2, 1920, pp. 133–135. Discussion of R. Nimführ's new but already tested, theory of the dynamic flight, according to which, the pressure of air is utilized as the supporting force. Describes how a constant atmospheric pressure wave is generated on which the airplane sails with much less consumption of power than would be the case with propeller drive. Describes how with the Nimführ flight theory, gravity can be overcome with employment of a single man power (equivalent to 1/4 hp.).

FLYING BOATS

Controls. Sand Test of Flying Boat Controls. Aviation, vol. 9, no. 11, Nov. 29, 1920, pp. 350–352, 7 figs. Account of tests on controls of aeromarine model 40 flying boat.

FOREMEN

Training of. Adopt Methods to Develop Foremen, M. C. Evans. Foundry, vol. 48, no. 24, Dec. 15, 1920, pp. 1001–1004. Detailed description of foreman's development course which was conducted during six months of last fall and winter at plants of International Harvester Co. Paper read before American Foundrymen's Association.

FORGING

Gas for. Gas for Forging. Gas Industry, vol. 20, no. 11, Nov. 1920, pp. 257–260. Requirements and advantages.

Why Gas Excels for Forging. Gas Rec., vol. 18, no. 9, Nov. 10, 1920, pp. 67–69. Experience of Henry L. Doherty Co.

Norfolk Navy Yard Shop. Forge Shop at the Norfolk Navy Yard, J. S. Glover. Am. Drop Forger, vol. 6, no. 11, Nov. 1920, pp. 555–558, 3 figs. Size, layout and equipment of plant. Compressed air used to operate hammers. Design of forges and oil atomizers. Butt-weld machine. Reclaiming propellers.

FOUNDRIES

Air Furnace for. Air Furnace Iron for Big Castings, H. E. Diller. Foundry, vol. 48, no. 24, Dec. 15, 1920, pp. 973–977, 8 figs. Air furnace used in

one of foundries of Westinghouse Electric & Mfg. Co.

Equipment. Choosing Correct Plant Equipment, Joseph J. Wilson. Foundry, vol. 48, no. 24, Dec. 15, 1920, pp. 985–988. Selection of machines and appliances exemplified in case of foundry of Saginaw Products Co., Saginaw, Mich. Paper read before National Founder's Association.

Germany. The G. Krautheim Foundry Plants in Chemnitz for Production of Cast Steel, Malleable and Gray Iron Castings (Die Stahl-, Temper- und Graugiesserei-Anlagen der Firma G. Krautheim in Chemnitz.) Stahl u. Eisen, vol. 40, nos. 39 and 43, Sept. 30 and Oct. 28, 1920, pp. 1293–1300 and 1443–1448, 22 figs. Description of works employing 1600 men, including original plant in Chemnitz-Altendorf, in which malleable and gray-iron castings are produced, and the new steel foundry in Chemnitz-Borna, with notes of arrangement of plant, small Bessemer plant, the open-hearth furnaces, the electric steel furnaces, the cleaning shop, molding shop, etc.

Organization. Training Executives for Foundries, Bruce W. Benedict and Robert E. Kennedy. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 903–907, 5 figs. Suggested organization for foundries. Shop training course at University of Illinois. Paper read before Am. Foundrymen's Assn.

[See also CORE OVENS.]

FOUNDRY EQUIPMENT

Developments. Foundry Equipment in Modern Plants, Joseph J. Wilson. Iron Age, vol. 106, no. 22, Nov. 25, 1920, pp. 1392–1397, 10 figs. Survey of recent developments.

FUELS

Colloidal. The Case for Colloidal Fuel, Lindon W. Bates. Chem. Age (Lond.), vol. 3, no. 75, Nov. 20, 1920, pp. 558–559. Economic advantages. Paper read before Instn. Petroleum Technologists.

[See also OIL FUEL; PULVERIZED COAL; RESEARCH, Liquid Fuels.]

FURNACES

Heat Flow Through Walls. Heat Flow Through Furnace Walls—II, E. F. Davis. Trans. Am. Soc. for Steel Treating, vol. 1, no. 2, Nov. 1920, pp. 128–140, 17 figs. Experimental measurements.

FURNACES, BOILER

Forced-Draft. Forced Draft Furnaces (Unterwindfeuerungen), L. Schmitt. Tonindustrie-Zeitung, vol. 44, no. 106, Sept. 7, 1920, pp. 938–939. Discussion of the relative value of forced-draft furnaces and steam-jet blowers, writer favoring the former.

Recommendations for the Development of Forced-Draft Furnaces (Vorschläge für den Ausbau der Unterwindfeuerungen), E. Nies. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 39, Sept. 24, 1920, pp. 297–299. Writer makes following suggestions: (1) The free surface of grate with use of under-grate draft should be reduced to from 4 to 6 per cent as against 35 to 40 per cent in plain horizontal grates; (2) grate bars and plates should be inserted accurately, and free surface of grate should not be changed, (3) in external furnaces the circulation of air through the side grate bars should be reduced; (4) in flue boilers, end of grate should be provided with a plate upon which the red coals can be shoved while cleaning the fire.

The "Turbine" Forced-Draught Furnace. Eng., vol. 110, no. 2863, Nov. 12, 1920, pp. 639–640, 8 figs. Arrangement consists of series of troughs which lie side by side and form base of furnace. Front of each trough forms air injector and is fitted with steam jet.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

FURNACES, HEATING

Labor-Saving Features. Heating Furnaces and Annealing Furnaces, W. Trinks. Blast Furnace & Steel Plant, vol. 8, no. 12, Dec. 1920, pp. 671–675, 12 figs. Labor saving features of different types of furnaces.

FURNACES, HEAT-TREATING

Electric Heaters. Electric Heaters for Heat Treating Furnaces—II, H. O. Swoboda. Am. Drop Forger, vol. 6, no. 11, Nov. 1920, pp. 540–543, 9 figs. Carbon and graphite resistors are used with success in several types of furnaces. Furnace charge is used as heater in special cases. Temperature control.

Oil-Burning. Annealing and Heat Treatment Furnaces, James E. Wilson. Jl. Engrs. Club of Phila., vol. 37–12, no. 192, Dec. 1920, pp. 488–489. Design, regulation of cost of oil-burning steel heat-treating furnaces.

FURNACES, OPEN HEARTH

Waste-Heat Boilers. Application of Waste Heat Boilers to Open Hearth Furnaces, Thomas R. Tate. Jl. Engrs. Club of Phila., vol. 37–12, no. 192, Dec. 1920, pp. 485–487. Design of proper size and type boiler for any installation. Paper read before Assn. Iron & Steel Elec. Engrs.

G

GAGES

Indicating. Indicating and Contour Gauges. Machy. (Lond.), vol. 17, no. 427, Dec. 2, 1920, pp. 259–263, 11 figs. Classification and description.

Limit. Limit Gauges. Eng., vol. 110, no. 2863, Nov. 12, 1920, pp. 643–644. Developments in standardization.

Limit Gauging, Richard T. Glazebrook. Jl. Instn. Mech. Engrs., no. 8, Dec. 1920, pp. 1075–1088, 5 figs. Diagram of grades of fit, and chart of limits. (To be continued.)

Limit Plug. Quantity Production of Combination Limit Plug Gauges. Machy. (Lond.), vol. 17, no. 423, Nov. 4, 1920, pp. 151–153, 4 figs. Combination limit plug gage introduced by Taft-Pierce Mfg. Co., Woonsocket, R. I.

Screw-Thread. Hardening Screw Gauges with Least Distortion, Wilfred J. Lincham. Can. Machy., vol. 24, no. 22, Nov. 25, 1920, pp. 472–476, 14 figs. Method developed at Goldsmith's College, London.

GAS ENGINES

Castings. Problems Encountered in Gas Engine Castings, Pat Dwyer. Foundry, vol. 49, no. 24, Dec. 15, 1920, pp. 980–983, 9 figs. Casting practice at plant of Rathbun-Jones Engineering Co., Toledo, Ohio.

Valveless. The Development of Two-Stroke High-Power Gas Engines (Weiterentwicklung der Zweitakt-Grossgasmaschinen), W. Bertram. Stahl u. Eisen, vol. 40, no. 40, Oct. 7, 1920, pp. 1335–1340 and (discussion) pp. 1340–1341, 5 figs. Describes construction and operation of new valveless gas engine of the Dahlbrucher Machine Construction Corp'n, and gives operating results of engine reconstructed according to this type.

GASOLINE

Production of. Production of Gasoline. Power, vol. 52, no. 20, Nov. 16, 1920, pp. 788–789. Statistics of refinery production of gasoline for period of sixteen years, 1904 to 1919, inclusive. Advance publication of Bureau of Mines Bulletin No. 191.

Specifications. Aviation Gasoline Specifications and Methods for Testing. Air Service Information Circular, vol. 1, no. 46, Aug. 30, 1920, 8 pp. 3 figs. Specifications cover three grades of gasoline known as domestic aviation gasoline, export gasoline and fighting gasoline. Distillation test is required for determining grade of gasoline. Procedure and details of manipulation in conducting distillations are explained.

GASOLINE ENGINES

Two-Cycle. The Two-Cycle Lutin Motor (Le moteur à 2 temps Lutin), H. Petit. Vie Automobile, vol. 16, no. 717, Nov. 10, 1920, pp. 420–421, 3 figs. Piston is enlarged at base and fits in larger cylinder. Lower element of piston is used for compressing mixture before charging into upper cylinder.

GEARS

Bevel. A New Development in Bevel Gear Cutting. Machy. (Lond.), vol. 17, no. 425, Nov. 18, 1920, pp. 199–203, 8 figs. Attachments applicable to ordinary shaping machine.

Design. Graphical Method for Designing a Set of Complex Gears (Méthode graphique par anamorphose pour l'établissement des trains d'engrenages complexes), Luc Denis. Vie Technique et Industrielle, vol. 1, no. 9, June 1920, pp. 221–222, 3 figs. Examples. (Concluded.)

Involute. Involute Teeth, Richard Gardner. Eng., vol. 110, no. 2864, Nov. 19, 1920, pp. 659–660, 2 figs. Design formulas.

Machining Blanks. Machining Friction Gear Blanks and Friction Cones, J. H. Moore. Can. Machy., vol. 24, no. 17, Oct. 21, 1920, pp. 371–373, 8 figs. Examples of work performed according to practice of Foster Machine Co., Elkhart, Ind.

Pitch-Measuring Machine. The Wickman Pitch Measuring Machine. Automobile Engr., vol. 10, no. 145, Dec. 1920, p. 481, 4 figs. Machine is designed to measure tooth spacing at pitch line as well as concentricity of pitch circle with bore.

Reduction. See REDUCTION GEARS.

Spur. Backlash Standards for Spur Gears, Charles H. Logue. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1040–1041, 2 figs. Formula for determining proper backlash for spur gears, and tables computed from formula.

Welding of. The Art of Welding Gears and Pinions, F. H. Sweet. Blast Furnace & Steel Plant, vol. 8, no. 12, Dec. 1920, pp. 684–685. Advisability of welding each tooth separately or of welding several teeth en bloc. Selection of proper welding tip and filler rod.

GIRDERS

Design. Reduction of Girder and Column Live Loads, C. R. Young. Can. Engr., vol. 39, no. 23, Dec. 2, 1920, pp. 565–569, 2 figs. Principle of discounting improbable live loads generally observed. Intensity of floor loads for buildings varies inversely as tributary area. Review of various reduction rules. New specification suggested.

Stresses in. Notes on Impact, F. W. Gardiner. Proc. Am. Soc. Civil Engrs., vol. 46, no. 9, Nov. 1920, pp. 976–977. Relation between static and dynamic stresses in girder spans for smooth rolling loads. It was found that for speeds that obtain in railroad practice dynamic effect of smooth rolling loads may be neglected; dynamics increment of stress for single load for critical speed is given as 31.8 per cent. (Abstract.)

GLUES

See AIRCRAFT CONSTRUCTION MATERIALS, Casein Glue.

H

HANDLING MATERIALS

Railway Shops. Handling Material in Railway Shops, Frank A. Stanley. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 953–954, 7 figs. Typical labor-saving devices.

HANGARS

Design. Hangars for Dirigibles and Their Accessories (Les gares de dirigeables et leurs accessoires), M. J. Sabatier. Aéronautique, vol. 2, no. 14, July 1920, pp. 55–60, 12 figs. Scheme of turning German man hangars around on base.

HARDNESS

Instruments for Testing. Rapid Measurement of Hardness and Resilience of Metals (Mesures rapides de la dureté et de la résilience des metaux), S. Boisthorel. Nature (Paris), no. 2427, Oct. 9, 1920, pp. 230–234, 10 figs. Guillery portable apparatus for use in workshops.

Measurement of. The Measurement of the Hardness of Metals, Hugh O'Neill. Mech. World, vol. 68, no. 1769, Nov. 26, 1920, pp. 383–384, 2 figs. Classification of methods. Discussion of their relative advantages and disadvantages. (To be continued.) Paper read before Sheffield University Metallurgical Soc.

HEATING

Electric. Economic Heating by Means of Hydroelectric Energy (La produzione economica del calore mediante l'energia idroelettrica), C. Baulino. L'Elettrotecnia, vol. 7, no. 18, June 25, 1920, pp. 318–320, 1 fig. Scheme involving passage of heat at low temperature into high temperature by utilization of mechanical energy.

HEAVY-OIL ENGINES

Pistons. Piston and Rings for Heavy Oil Engines, W. D. Forbes. Mar. Eng., vol. 25, no. 12, Dec. 1920, pp. 1002–1003, and p. 1013. Solid and forged pistons discussed. Method of forming piston rings from castings. Assembling forged pistons.

HELICOPTERS

Hewitt-Crocker. The Hewitt-Crocker Helicopter, Francis Bacon Crocker. Aerial Age, vol. 12, nos. 11 and 12, Nov. 22 and 29, 1920, pp. 295–297, 4 figs., and 323–325, 1 fig. Machine comprises upper propeller revolving in normally horizontal plane and propeller in parallel plane 7 ft. below. Each propeller is 51 ft. in diameter. Propellers revolve in opposite directions.

Problem of. The Problem of the Helicopter, Louis Damblanc. Aeronautics, vol. 19, nos. 371 and 372, Nov. 25 and Dec. 2, 1920, pp. 379–381 and 392–394. Also Flight, vol. 12, no. 48, Nov. 25, 1920, pp. 1219–1223, 10 figs. Comparative study of two proposed types of helicopters, (1) machine with single axis and (2) that with separate axis. Paper read before Royal Aeronautical Soc.

Propellers of. Note on Supporting Propellers (Note sur les hélices sustentatrices), M. Lamé. Aérophile, vol. 28, nos. 17–18, Sept. 1–15, 1920, pp. 269–270, 1 fig. Characteristics of propeller which would permit by its free rotation safe falling of helicopter.

HOISTING ENGINES

Emergency Governor. An Emergency Governor with Hoist Recorder Gives Data on Safety and Efficiency, G. F. Royer. Coal Age, vol. 18, no. 22, Nov. 25, 1920, pp. 1079–1084, 4 figs. Emergency governor for control of clutch-drum hoisting engines.

HOISTS

Drum Design. Calculation of Stresses in Winding-Drum Flanges. Am. Mach., vol. 53, no. 25, Dec. 16, 1920, pp. 1130–1131, 2 figs. Diagrams of forces acting.

Rational Design of Hoisting Drums, Everett O. Waters. Mech. Eng., vol. 4., no. 12, Dec. 1920, pp. 675–679, 9 figs. Theoretical formula is deduced for total pressure against drum flange caused by winding-on of rope to given depth and under given initial tension. Two other formulas are also deduced, which relate total pressure to flange thickness and maximum allowable tensile and shearing stresses in material. By means of these formulas flange of usual mushroom type may be designed to withstand safely pressure of rope wound upon drum.

HOUSING

England. Concrete Cottage Building. Concrete and Constructional Eng., vol. 15, no. 11, Nov. 1920, pp. 737–742, 5 figs. Meanwood housing scheme, Leeds.

Industrial. Solving the Housing Problem, Herbert Hoover, Leslie H. Allen, Philip W. Blake and W. Gibbs Astle. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 425–436, 8 figs. Why industrial executives must do it and how it is being done.

Legislation in England. The Garden City and English Housing Laws, Leonard S. Smith. Eng. and Contracting, vol. 54, no. 21, Nov. 24, 1920, pp. 510–513, 2 figs. Resolutions adopted at World Congress on Housing and Town Planning held in London, June, 1920.

Schemes. Housing and Community Planning, John Irwin Bright. Jl. Am. Inst. of Architects Supp. 8 pp., 4 figs. Scheme developed by Committee on Community Planning of American Institute of Architects.

HYDRAULIC TURBINES

High-Head. Turbines for Niagara's High-Head Plant. Iron Age, vol. 106, no. 23, Dec. 2, 1920, pp. 1453–1457, 11 figs. Normal operating capacity will be 52,500 hp. and net effective head, 305 ft.

Radial-Flow. New Methods of Constructing Turbines and Regulators (Neue Wege des Turbinen- und Regulatorenbaues), Erwin Sonnek. Zeit. für das gesamte Turbinenwesen, vol. 17, no. 27, Sept. 30, 1920, pp. 318–320, 5 figs. Writer describes his new regulation for full-jet turbines which consists of a changeable width of rim for centrifugal and inward radial-flow turbines; and his hydraulic regulator which is equipped with two separate regulating valves, one for opening and the other for closing main inlet. Abstract of address delivered before Austrian Assn. of Engrs. & Architects.

Theory of. New Analytical Theory of Water Turbines. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 689–692, 1 fig. Formulas combining various elements of turbines. Translated from Technique Moderne.

HYDROELECTRIC PLANTS

Abitibi River. Twin Falls Development on Abitibi River, Harold L. Trotter. Can. Engr., vol. 39, no. 25, Dec. 16, 1920, pp. 605–609, 9 figs. New plant for Abitibi Power & Paper Co. to have five 6000-hp. vertical turbines. Concrete dam across river raises headwater 57 ft. Reinforced-concrete power house. Description of construction methods and plant.

Auxiliary Equipment. Efficiency of Installing Energy Accumulators of Small Output in Hydroelectric Central Stations (Sur l'efficiacité de l'adjonction de systèmes accumulateurs d'énergie même à bas rendement aux centrales hydrauliques), A. Della Riccia. Revue générale de l'électricité, vol. 8, no. 17, Oct. 23, 1920, pp. 555–564, 7 figs. Special reference is made to installation of a heat accumulator suggested by M. Del Proposto, which consists of a set of boilers heated by the flow of hot oil, in combination with ordinary water-tube boiler. Oil is heated electrically in special cylinder. Steam from system operates turbine directly coupled with generator.

Brazil. Development of Hydroelectric Plants. Commerce Reports, no. 43b, Nov. 24, 1920, p. 10. Developments in Brazil.

France. The Eget Plant of the French Southern Railway (L'usine d'Eget de la Compagnie des Chemins de Fer du Midi), M. Barbillion. Industrie Électrique, vol. 29, no. 678, Sept. 25, 1920, pp. 345–350, 7 figs. Details of conduits. (Concluded.)

The Hydroelectric Plants at Rioupéroux (L'usine de Rioupéroux), M. Barbillion. Industrie Électrique, vol. 29, no. 679, Oct. 10, 1920, pp. 363–370, 19 figs. Hydroelectric central station producing single-phase current at 8200 volt and three-phase current at 63,000 volt. Power is supplied to metallurgical industries in neighborhood.

Hydrographic Studies. Hydrographic Study Preliminary to Utilizing the Water Power of a Mountain Basin (Étude hydrographique et aménagement d'un bassin montagneux), G. Malforn. Électricien, vol. 36, no. 1262, Oct. 15, 1920, pp. 433–436, 3 figs. Plan for utilization of basin in Italian Alps. (To be continued.)

Ice Protection. Ice Protection for Hydroelectric Plant, John S. Carpenter. Power Plant Eng., vol. 24, no. 23, Dec. 1, 1920, pp. 1125–1126, 2 figs. Methods of deflecting ice jams.

Kerckhoff Development. Kerckhoff Power Development—A western Achievement, J. M. Buswell. Power, vol. 52, no. 24, Dec. 14, 1920, pp. 926–934, 14 figs. Project includes concrete, constant-angle arch dam across main San Joaquin River; 18 x 18 ft. unlined pressure tunnel 16,875 ft. long; steel triple-penstock line; reinforced-concrete power house, housing three 15,000-hp. vertical-shaft turbines to operate under head of 315 to 340 ft. and directly connected to 14,200-kva. vertical-shaft generators.

New Brunswick. Hydro-Electric Power Development in New Brunswick, C. O. Foss. Can. Engr., vol. 39, no. 23, Dec. 2, 1920, pp. 576–578. Two plants of 8000 hp. capacity each. Paper read before Eng. Inst. of Canada.

Norway. The Hydroelectric Plant at Vamma, Norway (L'usine hydroélectrique de Vamma (Norvège). Génie Civil, vol. 77, no. 21, Nov. 20, 1920, pp. 414–416, 3 figs. Total capacity will be 200,000 hp. Head varies from 25 to 27 m. and flow is about 220 cu. m. per sec.

Nova Scotia. Sheet Harbour Hydro-Electric Powers, Harold S. Johnston. Jl. Eng. Inst. Canada, vol. 3, no. 12, Dec. 1920, pp. 565–575, 4 figs. Schemes proposed with tables of run-off, etc.

Seattle, Wash. Seattle Building Large Municipal Hydro-Electric Development, C. F. Uhden. Eng. News-Rec., vol. 85, no. 21, Nov. 18, 1920, pp. 994–996, 2 figs. Project for development of Upper Skagit River where ultimately about 500,000 hp. can be obtained.

South America. Survey of Power Plant Projects in South America. Power Plant Eng., vol. 24, no. 24, Dec. 15, 1920, pp. 1171–1173. Prepared by Guaranty Trust Co. of New York.

Surplus Water. Wasting Surplus Water at Hydro-electric Plants, L. W. Wyss. Power Plant-Eng., vol. 24, no. 23, Dec. 1, 1920, pp. 1126–1128, 3 figs. Description of various kinds of gates used to regulate overflow in hydroelectric stations.

Sweden. Utilizing Hydro-Electric Energy in Sweden. Elec. World, vol. 76, no. 24, Dec. 11, 1920, pp. 1167–1170, 2 figs. Experience with extensive high-tension system of Swedish Government. Method of grading station insulation and studies of lightning trouble. Plans for 200,000-volt transmission lines.

Switzerland. The Great Modern Hydroelectric Plants in Switzerland (Grandi impianti idroelettrici moderni in Isvizzera), Giovanni Rodio. Industria, vol. 34, no. 17, Sept. 15, 1920, pp. 425–431, 14 figs. Utilization of low head of Reno River at Eglisau. Maximum capacity is 42,000 hp. (To be continued.)

Utilization of Freshet Water. Utilizing Freshet Water for Power Generation, Clemens Herschel. Power, vol. 52, no. 22, Nov. 30, 1920, pp. 861–862, 1 fig. With properly designed venturi tube installed in discharge of hydraulic turbine power output can be increased maximum of 30 per cent by utilizing freshet water that would otherwise run to waste over dam.

HYDROPLANES

French. The French Hydroplanes at Antwerp (Les Hydroglisseurs Français a Anvers). Aéronautique, no 16, Sept. 30, 1920, pp. 152–154, 5 figs. Boats operated by aeroplane and propeller. Diagrams showing power required and resistance to traction.

I

ICE PLANTS

Electrically Driven. Electric Driven Raw Water Ice Plant, George B. Bright. Ice and Refrigeration, vol. 59, no. 6, Dec. 1920, pp. 246–248. Data and cost of operation.

Freezing Tanks. Ice Tank of New Design Gives Remarkable Results, C. Wilkie. Power, vol. 52, no. 21, Nov. 23, 1920, pp. 823–826, 8 figs. Ice tank is 114 ft. long, holding 856 cans, freezing 400-lb. blocks. Direct-expansion coils are in one end, flooded coils with horizontal accumulator in other end. 7 in. of agitation is produced by one propeller, 36 in. in diameter, at center of tank.

IGNITION

Battery Systems. A Compact Battery Ignition System. Automotive Industries, vol. 43, no. 24, Dec. 9, 1920, pp. 1162–1163, 4 figs. System designed by Vital Paquit, Belgian engineer. Arrangement combines usual battery ignition units into small assembly resembling magneto in appearance and method of connection with engine.

INDUSTRIAL MANAGEMENT

Exposed Records. The Influence of Exposed Records on Output, F. M. Lawson. Eng. & Indus. Management, vol. 4, no. 20, Nov. 11, 1920, pp. 615–617. Permanent advantages are said to be (1) there is less stock carried, which means shorter investment period and consequent saving in money; (2) a smaller staff is required owing to ease with which information can be obtained; and (3) there is less switching men off from one job to another, owing to ease with which accurate decisions can be made.

Inspection. How the Inspection Department Helps the Factory, George S. Radford. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 418–421. Coordination of inspection with cost, assembling, routing and productivity.

Machine Shops. Finds Efficiency Lacking in Many Shops, H. M. Fitz. Iron Age, vol. 106, no. 25, Dec. 16, 1920, pp. 1609–1611. Inspection trip of 70 shops and factories revealed fact that large percentage has only partial or no system of management.

Opinion of Workers. What the Workers Think About Management—II, Albert Fry. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 437–440. Opinions from ironworkers, carpenters, inspectors, blacksmiths, machinists, patternmakers and others on individual responsibility, mental and physical tests and coöperation.

Organization Plan. Organization Plan that Typifies Modern Management, S. H. Bullard. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 441–444, 1 fig. Production system and organization plan of Bullard Machine Tool Co.

Production Method. Small-Quantity Production Methods, Earle Buckingham. Machy. (Lond.), vol. 17, no. 426, Nov. 25, 1920, pp. 213–215, 4 figs. Application of interchangeable manufacturing principles to methods employed when producing machines in limited quantities.

Routing Materials. Routing Considered as a Function of Up-to-Date Management—III, H. K. Hathaway. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 445–451, 12 figs. Method of routing assembled, multi-part mechanism.

Statistical Control. Making Statistics Talk—I, M. C. Rorty. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 394–398, 6 figs. Elements of statistical control. Application of statistical graphics to forecasting future trends.

Time Study. See TIME STUDY.

INDUSTRIAL RELATIONS

Business Organization of Labor. Labor as a Business, Not a Commodity—New Plan Proposed to Secure Industrial Peace, George H. Cushing. Manufacturers Rec., vol. 78, no. 21, Nov. 18, 1920, pp. 131–132. Suggests as basic solution for labor difficulty organization of labor on business basis. According to plan suggested capital would contract with labor for a certain amount of work to be done and would pay for it as a unit. Workmen would unite and sell their labor through representatives.

Closed Shop vs. Closed Shop Principles Paramount, James A. Emery. Iron Age, vol. 106, no. 25, Dec. 16, 1920, pp. 1606–1608. Attitude and policy of labor unions during war. (To be continued.) Address delivered before National Founders' Association.

The Closed Union Shop Versus the Open Shop: Their Social and Economic Value Compared, Ernest F. Lloyd. Nat. Indus. Conference Board, no. 11, July, 1920, 27 pp. It is hoped that neither type will prevail or that no class or group may obtain an impregnable hold, but that the industrial conflict may continue to develop a constant approach to unity.

Industrial Democracy. What Makes a Labor Policy Successful? Norman G. Shidle. Automotive Industries, vol. 43, no. 20, Nov. 11, 1920, pp. 970–973, 1 fig. Industrial relations policy of Greenfield Tap & Die Corporation.

New Zealand. Conciliation and Arbitration in New Zealand. Nat. Indus. Conference Board, no. 23, Dec. 1919, 46 pp. Features of New Zealand legislation, and its operation in practice.

Open Shop. The Last Stand of the Open Shop, Roy W. Hinds. Coal Age, vol. 18, no. 21, Nov. 18, 1920, pp. 1037–1040, 2 figs. Developments of strike in coal fields of southern West Virginia and Kentucky.

The Open Shop Fight is a Fight for American Independence—The Closed Shop un-American and Destructive of all Individual Independence. Manufacturers Rec., vol. 78, no. 21, Nov. 18, 1920, pp. 106–108. Progress of movement for open shop throughout the United States.

Works Councils. A Works Council Manual. Nat. Indus. Conference Board, no. 26, Feb. 1920, 32 pp. 4 figs. Procedure for establishing works council.

Works Councils in the United States. Nat. Indus. Conference Board, no. 21, Oct. 1919, 135 pp. Results of studies of works councils in 225 American industrial establishments. Information, is brought down to August 1, 1919.

INDUSTRIAL TRUCKS

Transveyor. The Cowan Transveyor. Eng. and Indus. Management, vol. 4, no. 19, Nov. 4, 1920, pp. 598–600, 3 figs. Type of industrial truck for interdepartmental conveying, used in various British works.

INDUSTRY

Germany. Industrial Technique in Germany During the War (La technique et l'industrie de l'Allemagne pendant la guerre), M. C. Lemaire. Annales des travaux publics de Belgique, vol. 21, no. 12, Oct. 1920, pp. 707–779. Developments of substitutes for raw material. Recuperation of industrial wastes. Experiments of riveting processes. Briquetting of coke. Production of lignite.

Problems of Labor and Industry in Germany. Nat. Indus. Conference Board, no. 15, Sept. 1920, 65 pp. Open shop principle has been recognized as basis for all relations between employer and employee, in spite of the fact that labor is almost completely organized and the Government has been encouraging organization among employers and employees.

INSULATORS, HEAT

Diatomaceous Earth. Diatomaceous Earth, Norris Goodwin. Chem. & Metallurgical Eng., vol. 23, no. 24, Dec. 15, 1920, pp. 1158–1160. Origin and uses. Bibliography of articles in technical magazines and list of patents bearing on use of diatomaceous earth as heat insulant and building material.

Hot-Air-Pipe Coverings. The Insulating Value of Various Coverings for Hot Air Pipes as Determined by Tests at the University of Illinois. Am. Architect, vol. 118, no. 2343, Nov. 17, 1920, pp. 648–652, 4 figs. It is concluded that use of thin sheets of asbestos paper on bright tin heat pipes result in waste of heat. Uncovered bright tin pipes were found to be more efficient carriers of heated air. Accumulation of dust and dirt on pipes does not greatly alter amount of loss. It is advised that unless insulation excels uncovered bright tin in heat insulation properties it should not be used.

INTERNAL-COMBUSTION ENGINES

Developments. Improvements in the Field of Internal-Combustion Engines (Neuerungen auf dem Gebiet der Verbrennungskraftmaschinen). Wirtschafts-Motor, no. 10, Oct. 1920, pp. 18–20, 8 figs. Details of recently patented engines and auxiliary devices.

Fuel Combustion. The Combustion of Fuels in the Internal-Combustion Engine, Thomas Midgley, Jr. Jl. Soc. Automotive Engr., vol. 7, no. 6, Dec. 1920, pp. 489–497 and (discussion) pp. 497–499, 18 figs. Recently developed optical gas-engine indicator. Indicator cards obtained with different fluids. Theory of knock and of knock suppressors.

Ignition. See IGNITION.

Lubrication. Castor Oil (L'huile de ricin), M. Martinot-Lagarde. Aéronautique, vol. 2, no. 17, Oct. 1920, pp. 187–190. Its value as lubricant for internal-combustion engines.

Water Injection. Water Injection in Gas and Oil Engines. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 492–494. Consideration of application and effect.

[See also AEROPLANE ENGINES; AUTOMBILE ENGINES; DIESEL ENGINES; GAS ENGINES; GASOLINE ENGINES; HEAVY-OIL ENGINES.]

IRON

Electrodeposited. The Industrial Future of Electro-Deposited Iron, W. E. Hughes. Elecn., vol. 85, no. 2216, Nov. 1920, pp. 530–532, 4 figs. Developments in Europe.

Plates. Standard Specifications for Wrought-Iron Plates. U. S. Dept. Commerce, Bur. Foreign and Domestic Commerce, Industrial Standards, no. 27, 1918, 13 pp. Adopted by American Society for Testing Materials.

IRON ORE

World Supply. The Iron Ore Supplies of the World, F. H. Hatch. Geol. Mag., vol. 57, no. 677, Nov. 1920, pp. 504–517. Statistics by countries. From Lond. Times Trade Supp.

K

KINEMATICS

Acceleration Determinations. Acceleration Determinations—I, Henry N. Bonis. Am. Mach., vol. 53, no. 22, Nov. 25, 1920, pp. 977–981, 3 figs. General solution for Whitwork quick-return motion as generally applied to shaper mechanism.

Rolling Couples. Kinematic Study of Rolling Couples (Étude cinématique des couples de roulement), P. Massot. Technique Moderne, vol. 12, no. 4, April 1920, pp. 161–169, 20 figs. Application to design of machines of principles and formulas developed in previous installments. (Concluded.)

L

LABOR

Conservation of. Conservation of Labor, L. W. Wallace. Am. Mach., vol. 53, no. 24, Dec. 9, 1920, pp. 1104–1106. Address delivered at first meeting of American Engineering Council of Federated American Engineering Societies.

Hours of Work. Unwarranted Conclusions Regarding the Eight-Hour and Ten-Hour Workday. Nat. Indus. Conference Board, no. 14, Aug. 1920, 21 pp. Critical review of "Comparison of an Eight-Hour Plant and a Ten-Hour Plant," United States Public Health Bul. no. 106. It is claimed that conclusions presented therein are unscientific and unjustified by data offered, because the two plants from which data were obtained are not fairly comparable and basis of experience is too small to justify complete conclusions applicable to industry in general.

Strikes. See STRIKES.

Two-Shift vs. Three-Shift Day. The Development of the Technique of Changing from the Two-Shift to the Three-Shift Day in a Continuous Process, Robert B. Wolf. Jl. Engrs. Club of Phila., vol. 37–12, no. 192, Dec. 1920, pp. 463–469 and (discussion) pp. 469–478, 6 figs. Results obtained in three plants where change was made are illustrated and interpreted and suggestions are given in regard to change in management policy which should accompany change to three shifts.

LABOR TURNOVER

New York City. Labor Turnover in New York City. Am. Mach. vol. 53, no. 21, Nov. 18, 1920, pp. 933–935. Statistics

LABORATORIES

Aerodynamic. The New Testing Apparatus at the Airdynamic Institute at Saint-Cyr (Les Nouveaux Apparels D'Essais de l'Institut Aérotechnique de Saint-Cyr. Nature (Paris), no. 2426, Oct. 2, 1920, pp. 213–219, 10 figs. Airdynamic balance, wind tunnel and apparatus for testing propellers.

LAPPING

Modern Practice. Modern Lapping Practice. Machy. (Lond.), vol. 17 no. 423, Nov. 4, 1920, 129–137, 19 figs. Developments in lapping practice, including abrasives used in lap-charging methods, lapping thread gages, snap gages, measuring wires, flat surfaces, ring gages, die-casting dies and T-slots.

LATHES

Automatic. Recent Machine Tool Developments—XVII, Joseph Horner. Eng. vol. 110, no. 2864, Nov. 19, 1920, pp. 660–664, 10 figs. Types of automatic lathes.

Double-Carriage. Hamilton Double Carriage Production Lathe, J. V. Hunter. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1021–1022, 3 figs. Lathe equipped with two independent carriages, recently placed on market by Hamilton Machine Co., Hamilton O.

Turret. Efficient Automatic Machine Tool Records, F. Scriber. Can. Machy., vol. 24, no. 24, Dec. 9, 1920, pp. 513–514, 6 figs. Skeleton set-ups on turret chucking lathe are explained.

Using Turret Lathes in Railroad Shops, J. H. Moore. Can. Machy., vol. 24, no. 21, Nov. 18, 1920, pp. 447–451, 7 figs. Examples of their application to various kinds of work.

Universal Relieving Type. A New Universal Relieving Lathe. Machy. (Lond.), vol. 17, no. 426, Nov. 25, 1920, pp. 217–220, 5 figs. Final drive is by means of worm gearing. Built by Ward, Haggas & Smith, England.

LIGHTING

Factories. The Lighting of Shoe Factories, A. L. Powell and J. H Kurlander. Trans Illuminating Eng. Soc., vol. 15, on. 8, Nov. 20, 1920, pp. 603–630, 18 figs. Analyzes lighting requirements for individual machines and specifies what arrangement of illuminating apparatus best meets these needs.

Industrial. Some Out of the Ordinary Applications of Industrial Lighting, Samuel G. Hibben. Trans. Illuminating Eng. Soc., vol. 15, no. 8, Nov. 20, 1920, pp. 591–598 and (discussion) pp. 598–602, 17 figs. Recommendations in regard to method of mounting lamps.

New Incandescent Method. A New Incandescent Lighting Method (Ein neues Verfahren zur Glühlichtbeleuchtung). K. Bube. Zeit. für Beleuchtungswesen, vol. 26, nos. 15–16, Aug. 15–31, 1920, 116–117. Describes new patented method, in which a glower is brought into contact with solid fuel in the form of a paraffin core so that it absorbs the melting fuel and carries the flame. Points out advantages and economy of method.

LOCOMOTIVES

Articulated. Recent Types of Articulated Locomotives (Types récents de locomotives articulées), Lionel Wiener. Revue générale des Chemins de Fer, vol. 39, no. 3, Mar. 1920, pp. 155–210, 16 figs. European and American developments.

Australian. Standard Type Locomotives, New South Wales Government Railways Ry. Gaz., vol. 33, no. 20, Nov. 12, 1920, pp. 645–646, 2 figs. Express engine is of 4–6–0 type and freight engine of 2–8–0 type, both with outside cylinders.

Austrian. Four-Cylinder Compound Locomotive, with Six Coupled Driving Wheels and Superheaters, of the Württemberg State Railways (La locomotiva A 6 assi accoppiati (I–VI–O) A 4 cilindri compound, con surpriscaldamento del vapore, delle ferrovie dello stato del Württemberg. Industria, vol. 34, no. 19, Oct. 15, 1920, pp. 476–480, 6 figs.

Driving Box Shoes. Lining Driving Box Shoes and Wedges, J. McAllister. Ry. Mech. Engr., vol. 94, no. 12, Dec. 1920, pp. 788–791, 1 fig. Shoe and wedge layout. Pedestal jaw grinding machine.

Inspection. Report of the Bureau of Locomotive Inspection. Ry. Age, vol. 69, no. 25, Dec. 17, 1920, pp. 1071–1073, 1 fig. Outstanding feature of report of chief inspector of locomotives to Interstate Commerce Commission for fiscal year ending June 30, 1920, is increase in number of accidents and casualties resulting from failures of parts of locomotives and tenders. Application of water columns and other devices advocated.

Mikado. Mikado Type Locomotive for C.M. & St.P. Ry. Ry. Rev., vol. 67, no. 20, Nov. 13, 1920, pp. 729–731, 4 figs. Design is characterized by straightforwardness and follows closely details for light Mikado-type engines prepared by mechanical standards committee of United States Railroad Administration.

Mine. Flywheel Motor-Generator for the Drive of Mine Locomotives in Grängesberg (En svänghjulsomformare för gruvlokomotivdriften i Grängesberg), Gustaf Hjertén. Teknisk Tidskrift (Kemi & Bergsvetenskap), vol. 50, no. 9, Sept. 22, 1920, pp. 186–192, 14 figs. 225-hp. induction motor directly coupled with a d.c. dynamo, which is connected with the separately mounted flywheel having diameter of 2100 mm. and weighing 4800 kg. Formulas are presented for calculation of weight of wheel. Calculation of the losses in motor-generator and friction losses of flywheel.

Repairing. The Zwilling Staybolt (Der Stehbolzen "Zwilling"), H. de Neuf. Annalen für Gewerbe u. Bauwesen, vol. 87, no. 5, Sept. 1, 1920, pp. 35–38, 5 figs. Economic advantages of new type are said to be that it (1) reduces time required to repair locomotives, (2) increases life of locomotives, (3) diminishes work in shop, (4) affords possibility, with equipment and personnel of existing workshops, to reconstruct many more locomotives than heretofore, and (5) greatly reduces number of bolts required because of its durability.

Steam vs. Electric. Relative Advantages of Modern Steam and Electric Locomotives. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 12, Dec. 1920, pp. 1044–1048. Comparison of two types, based on actual method of operation. Discussion at joint meeting of New York Sections of American Institute of Electric Engineers and Am.Soc.M.E.

Steam vs. Electric Locomotives, John E. Muhlfeld, F. H. Sheparo, A. H. Armstrong. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 680–687 and (discussion) pp. 687–688 and p. 726, 1 fig. Comparison in regard to initial and maintenance costs, reliability of service, efficiency of operation, and suitability of design. Data obtained in actual service of both types are presented and discussed.

Superheater. Steam Distribution with Superheated Steam. Ry. and Locomotive Eng., vol. 33, no. 12, Dec. 1920, pp. 368–370. Experiments made by French engineers in use of rotating valves. Translated from Génie Civil.

Technique. The Technique of Steam Locomotives (La technique des locomotives a vapeur), P. Drosne. Technique Moderne, vol. 12, no. 4, April 1920, pp. 145–150, 8 figs. Dynamic studies of steam locomotives. Graph comparing resistance curve obtained by calculation and by actual measurements of Pacific, Atlantic and 0–4–0 types.

LUBRICANTS

Requirements for. Anisotropic Fusion—Ideal Lubricants (Fusion anisotrope-lubréfiants idéaux), Marcel Brillouin. Journal de Physique, vol. 6, no. 2, Aug. 1920, pp. 33–38. Technical. It is held that unilateral or bilateral fluidity, rather than isotropic constitution, is ideal requirement for lubricant.

M

MACHINE TOOLS

Electric Equipment, Standardization of. Standardization of Electrical Equipment on Machine Tools. Iron Age, vol. 106, no. 21, Nov. 18, 1920, pp. 1322–1324 and pp. 1369–1371. Advantages of individual drive. Suggestions in regard to standardization.

Frame Design. The Stiffening of Machine-Tool Frames (Betrachtung über die Versteifung von Werkzeugmaschinenbetten), Ernst Peters. Betrieb, vol. 3, no. 2, Oct. 25, 1920, pp. 38–39, 3 figs. It is claimed that in machine-tool frames up to present time the twisting stress has not received sufficient consideration, and it is this that causes perceptible deformations and vibrations. Describes the zigzag rib constructed by author which, without increasing weight, is said to reduce the elastic deformation to fraction of its formet value.

Glasgow Exhibition. The Glasgow Shipbuilding, Engineering, and Electrical Exhibition. Eng. Production, vol. 1, no. 13, Dec. 1920, pp. 475–476. Survey of most important tool and machine-tool exhibits.

Lead Screws. Precision Lead Screws. Machy. (Lond.), vol. 17, no. 423, Nov. 4, 1920, pp. 125–128, 5 figs. Grinding and inspection methods of Drummond Bros., Guildford, England.

Sawmill Machinery. Building Saw Mill Machinery, Fred H. Colvin. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1030–1032, 7 figs. Machine-tool equipment in typical plants in Pacific Coast States.

Small Machines. Small Machines for Building Optical Instruments, J. V. Hunter. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1045–1047, 6 figs. Miniature machines for use in manufacture of delicate instruments.

MACHINERY

Foundations. Foundations for Machinery, N. W. Akimoff. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 671–672 and p. 699, 3 figs. Theory of causes leading to vibrations of machinery. Means for localizing expected vibration and of controlling resulting periods.

MALLEABLE IRON

American Industry. American Malleable Cast Iron—I, H. A. Schwartz. Iron Trade Rev., vol. 67, no. 23, Dec. 2, 1920, pp. 1536–1540, 4 figs. Series of related articles dealing with development of industry. Modern methods of manufacture, metallurgical principles involved and properties of American malleable iron.

Research. See RESEARCH, Malleable Iron.

MARINE BOILERS

Manufacture. Conference on the Unification of Rules for the Construction of Marine Boilers and Steam Pipes. Steamship, vol. 32, no. 378, Dec. 1920, pp. 153–155, 3 figs. Standard conditions for design and construction of marine boilers issued by British Board of Trade, 1920. (To be continued.)

MATERIALS

Substitutes for Various. German War Substitutes, A. Belter. Sci. Am. Monthly, vol. 2, no. 4, Dec. 1920, pp. 333–336. Substitutes for metals, gasoline and benzine, lubricants and rubber. Translated from Industrie Chimique.

Testing. See NOTCHED-BAR TESTS.

MILLING

British Practice. Milling Operations on Herbert Lathes, I. W. Chubb. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 945–950, 22 figs. Practice in British shops.

Thread. The Side Angle of Milled Threads (Ueber Flankenwinkel gefräster Gewinde), H. Friedrich. Werkstattstechnik, vol. 14, no. 17, Sept. 1, 1920, pp. 464–468, 16 figs. Experiments carried out in the machining of long screw spindles with square thread on the thread-milling machines of the Schuttoff & Bässler Corp'n, Chemnitz, show that with the calculated side angles correct a very accurate thread can be produced, but if side angle is in the slightest degree smaller than calculated, imperfections result.

MILLING CUTTERS

Helical. Making "Curvex" Milling Cutters. Machy. (Lond.), vol. 17, no. 425, Nov. 18, 1920, pp. 188–196, 17 figs. Methods and equipment employed by Pratt & Whitney Co. in manufacture of formed milling cutters with helical flutes.

MILLING MACHINES

Continuous. Continuous Miller Does Facing Work. Iron Trade Rev., vol. 67, no. 23, Dec. 2, 1920, pp. 1548–1549, 2 figs. Continuous type milling machine for facing to length crankshafts, camshafts and work of similar character. Built by Newton Machine Tool Works, Philadelphia.

Tables. Making Milling Machine Tables, Leroy M. Sherwin. Foundry, vol. 48, no. 23, Dec. 1, 1920, pp. 953–956, 7 figs. Molding and melting practices. Paper read before Am. Foundrymen's Assn.

MOLDING METHODS

Flasks for Locomotive Frames. How a Long Steel Flask is Assembled, Geo. W. Childs. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 923–925, 5 figs. Method of assembling sections of flasks used in molding locomotive engine frames.

MOTOR PLOWS

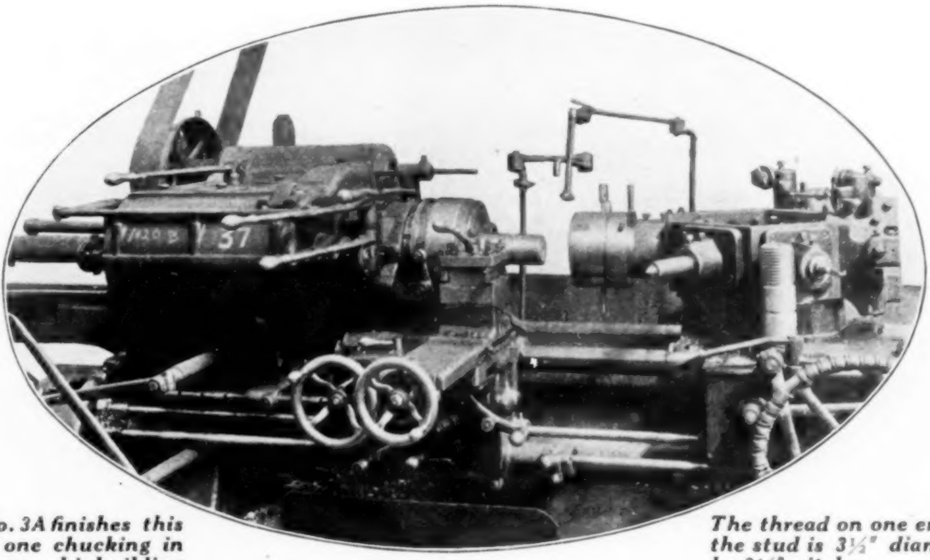
British-Made. Improved Mechanical Ploughing Appliances. Engr., vol. 130, no. 3383, Oct. 29, 1920, pp. 428 and 434–435, 6 figs. Motor cable plowing outfit manufactured by John Fowler & Co., Leeds, England.

MOTOR-TRUCK TRAFFIC

Legislation. The Automobile Should Be Major Factor in Highway Traffic. Automotive Industries, vol. 43, no. 24, Dec. 9, 1920, pp. 1179–1180. Plea that legislation be directed toward making traffic safe for vehicles.

MOTOR TRUCKS

Body Standardization. Now is the Time for Standardization in Truck Body Measurements, J. Edward Schipper. Automotive Industries, vol. 43, no. 20,



W & S No. 3A finishes this Stud in one chucking in a western shipbuilding plant.

The thread on one end of the stud is $3\frac{1}{2}''$ diameter by $3\frac{1}{4}''$ pitch.

ENGINEERING INDEX (Continued)

Nov. 11, 1920, pp. 962–963, 2 figs. Advantages of standardization. It is said that in addition to making lower price, it will be possible to make more competent and stable body building industry.

British Design. British Truck Show Reveals New Tendencies in Design, M. W. Bourdon. Automotive Industries, vol. 43, no. 24, Dec. 9, 1920, pp. 1154–1161, 16 figs. Decided changes in practice are noted since exhibition in 1913. Majority of trucks use overhead worm drive and pressed-steel frames are employed in three-fourths of models. T-head engine is being replaced by L-head type.

German. German Mechanical Transport Vehicles. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 466–477, 35 figs. Notes on collection of captured vehicles at Aldershot, England.

Radiators and Cooling Fans on the German War Trucks, Karl F. Walker. Automotive Industries, vol. 43, no. 20, Nov. 11, 1920, pp. 960–961, 4 figs. Based on reports of examinations made by Motor Transport Corps of U. S. Army. Practically all radiators of German war trucks contained sheet steel shell with ribbon type of core.

Olympia Show. The Commercial Motor Exhibition. Automobile Engr., vol. 10, no. 144, Nov. 1920, pp. 440–444, 11 figs. Trend of design in heavy vehicles as shown in exhibition at Olympia Show.

Specifications. Internal-Combustion Truck Specifications. Power Wagon, vol. 25, no. 193, Dec. 1920, pp. 42–59. Principle characteristics of 504 makes.

Tipping Gears. Tipping Gears for Lorries—II. Colliery Guardian, vol. 120, vo. 3122, Oct. 29, 1920, pp. 1230–1232, 10 figs. British design.

MOTORCYCLES

German Designs. German Motorcycles and Auxiliary Motors for Cycles (Deutsche Fahrradhilfsmotoren und Motorfahrräder), H. Bernhard. Wirtschafts-Motor, no. 10, Oct. 1920, pp. 5–9, 11 figs. Details of various German construction types, including those with motors above and in front wheel, above and in back wheel, within cycle frame, with motor on an extra wheel, etc. Distinction is made between motor cycles and auxiliary motors attachable to any cycle.

Springing. The Springing of Motor Cycles, C. H. Savage. Automobile Engr., vol. 10, no. 144, Nov. 1920, pp. 457–462, 17 figs. Discussion of experiments made in France. From results obtained suggestions are made in regard to position of springs and their dimensions.

N

NICKEL-CHROMIUM ALLOYS

Types. Nickel-Chromium Alloys, Leon O. Hart. Min. and Metallurgy, no. 168, Dec. 1920, p. 39. Properties of various types used. (Abstract.)

NOTCHED-BAR TESTS

Impact Tests. Experimental Study of Impact Tests on Notched Bars (Etude experimentale sur les essais au choc des barreaux entaillés), André Cornu-Thenard. Revue de Métallurgie, vol. 17, no. 9, Sept. 1920, pp. 584–614, 40 figs. Influence of speed of impact on results of tests. (Continuation of serial.)

NOZZLES

Coefficient of Discharge. The Coefficient of Discharge of Elementary Nozzles, A. A. Jude. Jl. Instn. Mech. Engrs., no. 8, Dec. 1920, pp. 977–1017 and (discussion) pp. 1018–1037, 10 figs. Discusses potentialities of series apparatus and clears up unsatisfactory features relating particularly to variability of coefficient over supercritical range.

Theory of. The Theory of Steam-Turbine Nozzles (Zur Theorie der Düsen von Dampfturbinen), Aug. Wewerka. Zeit. für das gesamte Turbinenwesen, vol. 17, nos. 23, 24 and 25, Aug. 20, 30 and Sept. 10, 1920, pp. 265–268, 277–280 and 294–297, 15 figs. Deals with following problems: (1) Change in values of condition of flowing medium when flowing through nozzle; (2) weight or volume of steam flowing through a given nozzle; and (3) maximum final velocity under different steam conditions in front and back of nozzle. Gives most important equations for flow in nozzles, and it is shown how curves of normal and inclined nozzles with reduction of back-pressure can be derived, and graphic solutions for development of the curves are given.

O

OIL FUEL

Burner for. New System for Burning Fuel Oil, Charles W. Geiger. Power Plant Eng., vol. 24, no. 24, Dec. 15, 1920, p. 1167, 1 fig. Burner in which air is introduced in burning oil.

Burning in Steam Cars. Liquid Fuel on Steam Waggons. Motor Traction, vol. 31, no. 819, Nov. 8, 1920, pp. 527–528, 3 figs. Application of Scarab liquid fuel system to Foden steam car.

Ships. Fuel Oil for Steamers, C. H. Peabody. Mar. Eng., vol. 25, no. 12, Dec. 1920, pp. 997–998. Grades of oil available for merchant vessels and their use.

Recent Advance in Oil Burning, Ernest H. Peabody. Twenty-eighth General Meeting, Soc. Naval Architects & Mar. Engrs., Nov. 11 and 12, 1920, no. 9, 11 pp., 8 figs. Progress in oil burning in ships of U. S. Navy. Graphs showing present efficiency obtained in boiler and furnace are included.

ORDNANCE

U. S. Navy Plant. Armor-Plate and Gun-Forging Plant of U. S. Navy, Roger M. Freeman. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 657–668, and p. 726, 15 figs. Attention is called to arrangements of stockyard alongside open-hearth building, 30-ton electric furnaces for duplexing, electric traveling cranes to carry 400,000-lb. ingots, original "H" type of forge shop and treatment plant combined, 14,000-ton steam-intensified hydraulic press, twenty 15-ft. wide Carbottom furnaces, machine shop with three 106-ft. wide aisles and gun-treatment building, high portion of which contains 75-ton crane of 104-ft. span on rails 165 ft. above floor level.

OXY-ACETYLENE CUTTING

Cast Iron. Cast Iron Cutting with Oxweld Blowpipe. Acetylene Jl., vol. 22, no. 6, Dec. 1920, pp. 318–322, 8 figs. Procedure.

Cutting Cast Iron with the Oxy-Acetylene Torch, Alfred S. Kinsey. Welding Engr., vol. 5, no. 11, Nov. 1920, pp. 34 and 36–37, 4 figs. Following points are emphasized: Cast iron can be "cut" by combined melting-oxidizing action of oxy-acetylene torch; cutting of cast iron, even though rather roughly done, will be of fine advantage to shop practice in several ways; special cutting torch is unnecessary provided one is used which operates with excess acetylene, etc.

OXY-ACETYLENE WELDING

School for. Michigan State Auto School's Special Welding and Brazing Course. Acetylene Jl., vol. 22, no. 6, Dec. 1920, pp. 315–317, 4 figs. Methods of instruction at oxy-acetylene welding school.

OXYGEN CUTTING

Jet-Cutting Machine. The Godfrey Jet-Cutting Machine. Machy. (Lond.), vol. 17, no. 425, Nov. 18, 1920, pp. 185–187, 4 figs. Machine tool using jet of oxygen as cutting medium. Manufactured by Godfrey Engineering Works, England.

P

PAPER MANUFACTURE

Pope Patent. A Description of the Pope Patent. Paper, vol. 27, no. 10, Nov. 10, 1920, pp. 28–30, 8 figs. Invention relates to means for winding web of paper produced by paper-making machine onto winding-roll.

PARACHUTES

Postal. Postal Parachutes (Les parachutes posteax), L. P. Frantzen. Aerophile, vol. 28, nos. 17–18, Sept. 1–15, 1920, pp. 280–282, 10 figs. Models developed in England, France and United States.

Release. The Van Meter Parachute Release. Aviation, vol. 9, no. 11, Nov. 29, 1920, pp. 344–345, 2 figs. Release is automatic in action after release rod is pushed and in addition incorporates many safety features in its construction. It is applicable to all open cockpit machines. Jumper is lifted from seat and carried clear of machine.

PATTERNMAKING

Shops. Rehabilitate Shop in Record Time. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 897–901, 7 figs. Organization and equipment of patternmaking shop of Bryan Pattern & Machine Co., Bryan, Ohio.

PISTON RINGS

Design. Piston-Rings, L. G. Nilson. Jl. Soc. Automotive Engrs., vol. 7, no. 6, Dec. 1920, pp. 525–531 and (discussion) pp. 531–536, 22 figs. Survey of developments in design. Specifications for material for piston rings.

PLANERS

Sellers 16-ft. The Sellers 16-ft. Planer. Am. Mach., vol. 53, no. 22, Nov. 25, 1920, pp. 973–976, 3 figs. Planer weighs nearly one-half million pounds and was recently completed by William Sellers & Co., for large shipbuilding company.

POWER TRANSMISSION

Sonic Waves. Transmission of Energy by Vibrations of Liquids in Conduits (Sur la transmission de l'énergie par les vibrations de liquides dans les conduits), C. Camichel, D. Eydoux and A. Foch. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 17, Oct. 26, 1920, pp. 783–786. Technical study of power transmission by Constantinesco system of sonic waves.

PRESSES

Briquetting Cast-Iron Turnings. The "Boreas" Briquetting Press for Cast-Iron Turnings. Eng., vol. 110, no. 2863, Nov. 12, 1920, p. 638, 3 figs. Made in Copenhagen by Danish Machine Co. Finished briquets are in form of truncated cones and each weighs about $6^1/_2$ lb.

Safety Device. Making the Punch Press Safe and Efficient, Norman G. Shidle. Automotive Industries, vol. 43, no. 23, Dec. 2, 1920, pp. 1118–1120 and 1133. Examples of safety devices used.

Tools. Press Tools for Caterpillar Parts, Frank A. Stanley. Am. Mach., vol. 53, no. 22, Nov. 25, 1920, pp. 987–988, 5 figs. Processes in manufacture of articles made from sheet metal or tubing.

PROFIT SHARING

Experience. Practical Experience with Profit Sharing in Industrial Establishments. Nat. Indus. Conference Board, no. 29, June 1920, 88 pp. Causes and circumstances which make some profit-sharing plans fail and others succeed.

Lyons Congress. Profit Sharing Recommended at Congress of Lyons (La participation aux bénéfices.—Le congrès de Lyon), F. Bayle. Revue générale de l'Électricité, vol. 8, no. 21, Nov. 20, 1920, pp. 735–739. Discussion of profit sharing as means for remedying industrial situation at Congress held at Lyon, October 1–2, 1920.

PULVERIZED COAL

Combustion. Pulverised Coal as Fuel. Lawford H. Fry. Eng., vol. 110, no. 2863, Nov. 12, 1920, pp. 628–631, 5 figs. Principles involved in combustion.

Grindle Burning System. For Burning Powdered Coal. Iron Age, vol. 106, no. 25, Dec. 16, 1920, pp. 1614–1615, 2 figs. Grindle equipment for burning powdered coal, manufactured by Combustion Economy Corporation, Chicago.

PUNCHING MACHINES

Tooling Arrangement. Two Light Punching-Machine Jobs, John Simon. Am. Mach., 53, no. 24, Dec. 9, 1920, pp. 1075–1077, 7 figs. Tooling practice in Austrian Machine Shop.

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RADIOMETALLOGRAPHY

Methods. Examination of Materials by X-Rays (Emploi des rayons X pour l'examen des materiaux). Ouvrier Moderne, vol. 3, no. 8, Nov. 1920, pp. 309–314, 11 figs. Apparatus employed and results obtained.

RAILS

Electrical Properties. Behavior of Rails as Conductors of Electricity (Sul comportamento delle rotaie impiegate come conduttori di corrente elettrica), Lino Sandonnini. Rivista Tecnica delle Ferrovie Italiane, vol. 18, no. 3, Sept. 15, 1920, pp. 94–103, 13 figs. Laboratory determinations of resistence, coefficient of self-inductions, and other electrical properties of rails.

Failures. Decrease in Rail Failures Confirmed by Latest Statistics. Eng. News-Rec., vol. 85, no. 23, Dec. 2, 1920, p. 1071, 1 fig. Statistics of rail failures for principal carriers.

Wheel Pressures and Steel Rail Failures. Iron Age, vol. 106, no. 22, Nov. 25, 1920, pp. 1399–1400. Report of Committee on Safety of Railroad Operation to convention of National Association of Railway and Utilities Commissioners. Heat treatment suggested as remedy for failures.

Sink-Head vs. Ordinary Ingots. Steel Rails from Sink-Head and Ordinary Rail Ingots—III, George K. Burgess. Chem. and Metallurgical Eng., vol. 23, no. 21, Nov. 24, 1920, pp. 1017–1022, 10 figs. Physical tests, metallographical examinations and chemical surveys. Comparison rails performed much better under drop test, and showed less abrasion under service tests.

RAILWAY ELECTRIFICATION

France. French Railways Electrifications—I. Elec. Ry. & Tramway Jl., vol. 43, no. 1055, Dec. 10, 1920, pp. 280–282. Translation of report issued by Ministry of Public Works. (To be continued.)

Holland. Electrification in the Netherlands (L'électrification des Pays-Bas), J.-C. Van Staveren. Vie Technique et Industrielle, vol. 1, no. 9, June 1920, pp. 204–206, 1 fig. Résumé of report of high tension committee appointed by association of directors of electric companies in the Netherlands.

Switzerland. Railway Electrification of the Erstfeld-Bellinzone Railway (Electrification de la ligne Erstfeld-Bellinzone). Bulletin Technique de la Suisse Romande, vol. 46, no. 21, Oct. 16, 1920, pp. 241–246, 5 figs. General description of works with notes on electric locomotives used.

The Electrification of the Gothard Railway. Ry. Gaz., vol. 33, no. 21, Nov. 19, 1920, pp. 668–670, 3 figs. Line is $139^1/_2$ miles long.

RAILWAY OPERATION

Emergency Car Service. Annual Report of Interstate Commerce Commission. Ry. Age, vol. 69, no. 24, Dec. 10, 1920, pp. 1019–1023. Review of year's activities under new law, including exercise of emergency car-service powers.

Payment of Wages. The Payment of Wages by Divisional Paymasters, T. W. Mathews. Ry. Age, vol. 69, no. 25, Dec. 17, 1920, pp. 1061–1064, 5 figs. Prompt and efficient payments effected on Seaboard Air Line by use of new check system.

RAILWAY REPAIR SHOPS

Chile. The New Railroad Shops at San Bernardo, Chile, Carlos Valenzuela Cruchaga. Am. Mach., vol. 53, no. 22, Nov. 25, 1920, pp. 982–986, 8 figs. Shops and equipment for repairing rolling stock of trunk line railway. Translated from Ingenieria Internacional.

Great Northern Railway. Car Repair Shops for the Great Northern Ry., P. P. Barthelemy. Ry. Rev., vol. 67, no. 20, Nov. 13, 1920, pp. 725–726, 3 figs. Standard type of frame construction, car repair shed.

RAILWAY SIGNALING

Angereau System. Repetition of Signals on the Locomotive (Répétition des signaux sur les locomotives), F. Limon and G. Lebaupia. Annales des Mines, vol. 10, no. 9, 1920, pp. 245–256, 1 fig. Angereau radio-telegraphic system, employed by French railways, for repetition of signals on locomotive.

Automatic Block. Passenger Terminal Facilities at Richmond, Va., C. J. Kelloway. Ry. Signal Engr., vol. 13, no. 12, Dec. 1920, pp. 490–494, 4 figs. Interlocking and automatic block signaling system.

ENGINEERING INDEX (Continued)

Three-Position Automatic System. The Signaling of the Ealing & Shepherd's Bush Railway. Ry. Gaz., vol. 33, no. 18, Oct. 29, 1920, pp. 571–577, 13 figs. Installation of three-position automatic signaling system, including special features with regard to control and working of signals and operation and detection of points.

RAILWAY TRACK

Construction. On the Question of the Construction of the Road Bed and of tne Track (Subjected for Discussion at the Ninth Congress of the International Railway Association), Mr. Henry and Mr. Candelier. Bul. Int. Ry. Assn., vol. 2, no. 10, Oct. 1920, pp. 639–664, 20 figs. Based on replies to questionnaire sent out to railway companies in Belgium, Bulgaria, Spain, France, Protugal and Switzerland. Questions referred to deformation noticed in track, amount of traffic carried, measures adopted and results obtained.

Design. Railway Track Design. Ry. Gaz., vol. 33, no. 20, Nov. 12, 1920, pp. 637 and 644. Compares bull-head with flat-bottom track, and suggests that advantages of latter justify its adoption in England.

Standardizing Work. Methods of Standardizing Track Work, Earl Stimson. Ry. Rev., vol. 67, no. 22, Nov. 27, 1920, pp. 813–816. Experience of Baltimore & Ohio Railroad.

RAILWAYS

Equipment Performance. A Remedy for Our Transportation Ills, O. W. Stiles. Freight Handling & Terminal Eng., vol. 6, no. 8, Aug. 1920, pp. 291–294. Organization of equipment performance as means for increasing service.

Interstate Commerce Commission. Annual Report of Interstate Commerce Commission. Ry. Age, vol. 69, no. 25, Dec. 17, 1920, pp. 1075–1078. Review of year's activities under new law, with references to work of several bureaus.

REDUCTION GEARS

Design. Propelling Machinery for the New Cunarders. Shipbuilding & Shipping Rec., vol. 16, no. 22, Nov. 25, 1920, pp. 631–633, 4 figs. Double-reduction geared turbines for "Scythia," "Laconia" and other vessels.

REFRIGERATING PLANTS

Fish Storage. Plant for Refrigerating Fish at Lorient, France (Le frigorifique à poissons de Lorient, Morbihan), M. Verrière and M. Tayon. Génie Civil, vol. 77, no. 13, Sept. 25, 1920, pp. 245–250, 16 figs. partly on supp. plate. Data: Storage capacity, 2000 tons of fish; ice-making capacity, 120 tons of ice per day.

RESEARCH

Heating and Ventilating. Heating and Ventilating Research Work. Domestic Eng. (Lond.), vol. 40, no. 23, Nov. 1920, pp. 167–168. Investigations carried out for Manchester Corporation Air Pollution Advisory Board. (Abstract.)

Liquid Fuels. The Proposed Research Association for Liquid Fuels. Steamship, vol. 32, no. 377, Nov. 1920, pp. 122–126. Suggestions in regard to general scheme of research association. Address delivered before Diesel Engine Users' Association.

Malleable Iron. British Grey and Malleable Cast-Iron Research Association. Foundry Trade Jl., vol. 22, no. 227, Nov. 1920, pp. 839–846. Account of inaugural meeting held at Birmingham, England, on Sept. 30, 1920.

Steel Research Committee. Notes on the Report of the Steel Research Committee, J. H. S. Dickenson. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 495–501, 7 figs. Committee was founded in 1916 jointly by Institution of Automobile Engineers and Society of Motor Manufacturers and Traders, to establish mechanical properties of ten standard automobile steels scheduled in B.E.S.A. Report No. 75.

RIVETED JOINTS

Stresses in. Determining True Net Sections of Riveted Tension Members by Diagrams. Can. Engr., vol. 39, no. 20, Nov. 11, 1920, pp. 512–513, 4 figs. Graphs give theoretically correct deductions of rivet holes for various gages and staggers.

RIVETING

Machines. English Type Electric Riveting Machine. Boiler Maker, vol. 20, no. 11, Nov. 1920, pp. 317–318, 5 figs. Manufactured by Mada Engineering Co.

Oiltight Work. Notes on Rivets and Spacing of Rivets for Oil-Tight Work, Hugo P. Frear. Twenty-eighth General Meeting, Soc. Naval Architects and Mar. Engrs., Nov. 11 and 12, 1920, no. 5, 10 pp. Rules and recommendations of American Bureau of Shipping, Bureau Veritas and Lloyd's Register.

Notes on Rivets and Spacing of Rivets for Oiltight Work, Hugo P. Frear. Mar. Eng., vol. 25, no. 12, Dec. 1920, pp. 1008–1009. Information concerning oiltight practice of riveting for oiltight work. (Abstract.) Paper read before Soc. Naval Architects & Mar. Engrs.

ROLLING MILLS

Alloy-Steels. New Rolling Mill for Alloy Steels. Iron Age, vol. 106, no. 25, Dec. 16, 1920, pp. 1597–1599, 6 figs. Installation of Pennsylvania Forge Co., Bridesburg, Philadelphia. Five stands are served by tilting table on one side and traveling lifting table on other with runout over transfer table.

Brass. New Plant of the West Virginia Metal Products Corp. Metal Industry (N. Y.), vol. 18, no. 12, Dec. 1920, pp. 543–548, 4 figs. Plant has eight-hour minimum capacity of 80,000 lb. of finished brass and 20,000 lb. of finished copper.

Electrically Driven. Electric Rolling-Mill Equipment for Messrs. Steel, Peech & Tozer, Ltd. Elec. Rev. (Lond.), vol. 87, no. 2244, Nov. 26, 1920, pp. 675–677, 5 figs. Billet mill is of Morgan type and consists of four stands of 21-in. rolls and six stands of 18-in. rolls, and is driven by 1200 hp., 6300-volt, 3-phase, 50-cycle B.T.H. slip-ring type induction motor. (Concluded.)

Electric Rolling-Mill Equipment for Messrs. Steel, Peech & Tozer, Ltd. Elec. Rev. (Lond.), vol. 87, no. 2243, Nov. 19, 1920, pp. 643–646, 7 figs. Substation and cogging-mill equipment. (To be continued.)

Factors which Determine the Selection of Motors for Main Roll Drive, G. E. Stoltz. Proc. Engrs. Soc. Western Pa., vol. 36, no. 7, Oct. 1920, pp. 492–507 and (discussion) pp. 508–517, 17 figs. Examination of types used in various steel mills. Suggestions in regard to selecting type of motor for proposed installation.

Motor Equipment for Main Drive of Rolling Mills. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 541–547. List giving particulars of British electrically driven rolling mills.

Notes on Rolling Mill Drives, L. Rothera. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 514–517, 5 figs. Examples showing progressive increase in motor size.

Sheet and Tin Mills, A. B. Holcomb. Assn. Iron & Steel Elec. Engrs., vol. 2, no. 11, Nov. 1920, pp. 1–11 and (discussion) pp. 11–27. Advantages of electric drive for sheet and tin mills.

The Electric Drive of Rolling Mills, W. E. Taylor and C. E. Raeburn. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 524–528, 3 figs. Comparative economy of steam and electric drives. Based on records of operation of Canadian mill by steam drive and after its conversion to electric drive.

The Electric Reversing Mill Considered from the Standpoint of Tonnage, K. A. Pauly. Gen. Elec. Rev., vol. 23, no. 11, Nov. 1920, pp. 886–892, 6 figs. It is shown that increase in production can be secured by electric drive with less than same percentage increase in first cost of equipment. Paper read before Assn. Iron & Steel Elec. Engrs.

Variable Speed Rolling Mill Drives, W. E. Swale. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 522–523, 3 figs. Relative advantages of direct and alternating current.

Furnaces. Repairs Involve Unique Problems. Iron Trade Rev., vol. 67, no. 21, Nov. 18, 1920, pp. 1401–1403, 5 figs. Complete reconstruction of Columbus furnaces of American Rolling Mill Co. carried out in short time.

American Rolling Mill Furnaces Remodeled. Iron Age, vol. 106, no. 21, Nov. 18, 1920, pp. 1318–1319, 5 figs. Remodeling included increase in volumetric sizes and entire reconsideration of hot stoves.

S

SAFETY

Shop, Organization for. Safety Work Must be Well Planned, R. A. Salisbury. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 895–896. Devise organized committees under direction of safety engineers and changing membership of committes frequently in order to educate workmen in safety.

Steel Works, Organization for. "Safety First" in a Steel works, H. S. Burn. Eng. and Indus. Management, vol. 4, no. 19, Nov. 4, 1920, pp. 589–590. Organization in large British Steel Works employing about 4000 workers.

SAND, MOLDING

Analysis. Judging Sands for Foundry Use—IV, Henry B. Hanlet and Herbert R. Simonds. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 921–922. Methods of testing.

Testing. Investigates Steel Sand Properties, R. L. Lindstrom. Foundry, vol. 48, no. 23, Dec. 1, 1920, pp. 940–943, 18 figs. Methods of testing. Qualities required. Paper read before Am. Foundrymen's Assn.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW THREADS

Specifications. Report on Coarse and Fine Threads. Can. Machy., vol. 24, no. 17, Oct. 21, 1920, pp. 374–377. Tables of tolerances, and specifications.

Standards. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 2, Oct. 25, 1920, pp. 17–21, 5 figs. Proposal of Board of Directors for flange joints, round threads and flat hexagonal threads. Proposed standards for sink-water traps with opening for cleaning.

SCREWS

Standards. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie), Betrieb, vol. 3, no. 1, Oct. 10, 1920, pp. 1–14, 17 figs. Proposals of the Board of Directors for special standard dimensional values and for driver's seat in agricultural machines. Proposed standards for square and hexagon head Whitworth cap screws, bolts and nuts, lag screws; sink-water traps, etc. Rules of the Committee for standards and formula values.

SHAFTS

Critical Speeds. Calculation of the Critical Speeds of Shafts (Die Berechnung kritischer Drehzahlen von Biegungswellen), H. Lorenz. Zeit. für das gesamte Turbinenwesen, vol. 17, nos. 20 and 21, July 20 and 30, 1920, pp. 229–232 and 245–249, 5 figs. Gives method for calculating critical speed of a shaft under a given load and arrangement of bearings which, however, can be applied only in simple cases. The employment of the Kull approximative formula is recommended for calculation of complicated cases.

Critical Speed and Gyroscopic Action (Kritische Drehzahl und Kreiselwirkung), R. Grammel. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 44, Oct. 30, 1920, pp. 911–914, 2 figs. Based on newly derived differential equation of a uniformly revolving vertical shaft, it is shown that, as a result of the gyroscopic action of the disks, there are no longer such unlimited number of critical revolutions; their number is determined according to the surface conditions; and it is explained how they can be altogether prevented. It is also explained how critical speeds vary when length of shaft or diameter of disk is changed. The critical speeds of the second class are investigated in same manner.

SHIPBUILDING

Great Britain. The Relation Between Shipbuilding Production, Prices, and the Freight Market, Maxwell Ballard. Trans. Northeast Coast Instn. Engrs. & Shipbuilders, Advance paper no. 3224–O, 17 pp., 8 figs. Economic position of shipping and shipbuilding industries of Great Britain.

Production Systems. Production Methods in Shipbuilding—V, William B. Ferguson. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 409–412, 2 figs. Discusses piece work in its application to shipbuilding and shows how varied nature of work involving many trades makes it necessary to depart from any one hard and fast system of bonus payment. Application of Halsey premium systems and 100-per cent time-premium plan and results obtained therefrom in increasing output of yard are set forth.

SNOW PLOWS

Rotary. The Development of Snow Fighting Equipment, W. H. Winterrowd. Ry. Maintenance Engr., vol. 16, no. 12, Dec. 1920, pp. 458–462, 8 figs. Rotary plows of Canadian Pacific Railways.

SOLAR ENERGY

Utilization of. Utilization of Solar Energy (Le soleil générateur de force motrice), Emmanuel Zoude. Revue Universelle des Mines, vol. 7, no. 4, Nov. 15, 1920, pp. 255–278, 12 figs. Method for generation of steam by solar rays invented by Frank Shuman of Philadelphia, and its application in installation at Meadi, Egypt, by British Corporation, owner of Shuman patents.

STEAM

Formulas. Steam Formulas, Robert C. H. Heck. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 669–670, 4 figs. Critical comparison of various existing formulations and development of new set of general equations. Formulas are developed for temperature, pressure and heat content.

Generation by Solar Rays. See SOLAR ENERGY.

Superheated, in Textile Mills. Superheated Steam in Textile Power Plants, Pell W. Foster, Jr. Textile World Jl., vol. 58, no. 23, Dec. 4, 1920, pp. 113–117, 4 figs. Its adaptability to the problems of textile-mill engineer.

STEAM-ELECTRIC PLANTS

Oshkosh, Wis. Electric Power at Oshkosh, Wis., T. J. Lucas. Power Plant Eng., vol. 24, no. 24, Dec. 15, 1920, pp. 1155–1161 and pp. 1186–1189, 15 figs. Replacement of reciprocating units by two vertical Curtis 500-kw. turbine units and later supplemented by 500-kw. horizontal Allis-Chalmers Parsons unit.

Unit Systems. Electrical Features of Springdale Plant, George S. Humphrey. Elec World, vol. 76, no. 23, Dec. 4, 1920, pp. 1114–1118, 8 figs. Details of 30,000-kw. unit of West Penn Power Co. Plant is arranged on unit system, main generator having its own boilers, auxiliaries, transformers and bus sections.

STEAM ENGINES

Piston Displacement. Piston Displacement, Velocity and Acceleration for Reciprocating Engines, John L. Bogert. Mar. Eng., vol. 25, no. 12, Dec. 1920, pp. 983–989, 10 figs. Table and graphs giving piston displacement, velocity and acceleration for various rations of connecting rod to crank.

Uniflow. Further Tests of the Uniflow Pumping Engine, D. A. Decrow. Jl. New England Water Works Assn., vol. 34, no. 3, Sept. 1920, pp. 195–199. Results of tests indicate that permissible speeds of this type of pumping engine are much higher than considered advisable for familiar types of crank and flywheel pumping engines; results as to speed economy indicate higher economy for higher speeds and temperatures.

STEAM POWER PLANTS

Test Codes. Power Test Codes. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 718–719 and p. 725. Preliminary draft of first of 19 codes which the American Society of Mechanical Engineers Committee on Power Test Codes is formulating.

STEAM TURBINES

Operation and Adjustment. Operation and Adjustment of Turbine Machinery—XII—Oil Pumps, Eustis H. Thompson. Power, vol. 52, no. 22, Nov. 30, 1920, pp. 863–864, 3 figs.

STEEL

Aircraft. Some Notes on Aircraft Steels and Their Inspection, R. K. Bagnall-Wild. Flight, vol. 12,

ENGINEERING INDEX (Continued)

no. 45, Nov. 4, 1920, pp. 1157–1158, 2 figs. British Air Board specifications. Paper read before Cambridge University Aeronautical Soc.

Alloy. See ALLOY STEELS.

Automobile. Automobile Steels. Ironmonger, vol. 172, no. 2451, Nov. 6, 1920, pp. 111–112. Report of Steel Research Committee founded by Institution of Automobile Engineers and Society of Motor Manufacturers and Traders on investigation conducted to establish mechanical properties of Bright Standard Wrought Automobile Steels. (Abstract.)

Basic. Reversion of Phosphorus to Basic Steel in the Ladle, Henry D. Hibbard. Blast Furnace & Steel Plant, vol. 8, no. 12, Dec. 1920, pp. 642–643. Conditions upon which quantity of phosphorus to revert depends. Fundamental cause of reversion of phosphorus due to presence of reducing elements.

Brinell Hardness and Grain Size. A Study of the Relation Between the Brinell Hardness and the Grain Size of Annealed Carbon Steels, Henry S. Rawdon and Emilio Jimeno-Gil. Sci. Papers Bur. of Standards, no. 397, Sept. 20, 1920, pp. 557–593, 5 figs. Brinell hardness was determined for five steels varying in carbon content from very low value to somewhat above one per cent. Each of steels was treated so as to produce wide variations in grain size and hardness was determined in each condition. Results showed no appreciable or consistent difference between hardness of small groups of crystals and average hardness of steels investigated.

Carbonization. Carbonizing So As To Insure a Tough Core, Earl W. Pierce and John W. Anderson. Iron Age, vol., 106, no. 21, Nov. 18, 1920, pp. 1315–1316. New method of carbonizing straight low carbon steel with carbon content carying from 0.15 to 0.25 per cent.

Cementite. On the Formation of Spheroidal Cementite, Kôtarô Honda and Seizô Saitô. Sci. Reports of the Tôhoku Imperial University, vol. 9, no. 4, Aug. 1920, pp. 411–317, 12 figs. on 2 supp. plates. Results of experiments show that if a quenched specimen be heated to below Ac_1 point, sorbitic cementite spheroidizes; if a hyper-eutectoid steel be heated above Ac_1 point, but below solubility line, and quenched, spheroidization of portion of super-eutectoid cementite takes place; if a lamellar pearlitic steel be heated to just the Ac_1 point or a little above it, for certain interval of time, spheroidization takes place; etc.

On the Saturation Value of Magnetisation of Cementite, Seizô Saitô. Sci. Reports of the Tôhoku Imperial University, vol. 9, no. 4, Aug. 1920, pp. 319–322, 10 figs. 8 on supp. plate. It is shown that cementite is magnetically harder than ferrite; difference between magnetization at room temperature and that at 300 deg. cent. is due to magnetization of cementite contained in specimen, this difference must therefore be proportional to amount of cementite present in specimen.

On the State of Carbide in Carbon Steels Quenched and Tempered, Seizô Saitô. Sci. Reports of the Tôhoku Imperial University, vol. 9, no. 4, Aug. 1920, pp. 281–287, 29 figs. on 3 supp. plates. Results of investigation are said to show: From point of view of X-ray analysis, carbon dissolves in iron as carbon atoms or as cementite, meaning thereby the same atomic configuration; by tempering a quenched steel at about 300 deg. cent., cementite is first set free, but owing to fineness of particles, its greater part readily decomposes into its components, iron and carbon, etc.

Heating Curves. Thermal and Physical Changes Accompanying the Heating of Hardened Carbon Steels, Howard Scott and H. Gretchen Movius. Dept. of Commerce Sci. Papers of Bur. of Standards, no. 396, Sept. 20, 1920, pp. 537–556, 11 figs. Transformation on heating curves of hardened steel and its characteristics as revealed in carbon steels were investigated experimentally. Principal temperatures for 0.95 per cent C martensitic steel were found to be 155, 250, and 260 deg. cent., respectively, for beginning, maximum, and end.

Magnetic Analysis. Magnetic Analysis of Steel, Charles W. Burrows. Sci. Am. Monthly, vol. 2, no. 4, Dec. 1920, pp. 341–344, 5 figs. Apparatus for testing magnetic homogeneities along length of steel specimens.

Nitrogen, Effect of. Some Notes on the Effect of Nitrogen on Steel, O. A. Knight and H. B. Northrup. Chem. & Metallurgical Eng., vol. 23, no. 23, Dec. 8, 1920, pp. 1107–1111, 8 figs. Experiments showed that at least five definite layers are produced on surface of low-carbon steel when it is exposed to ammonia at 650 deg. cent. Excessive brittleness in outer zones is held responsible in part for gun erosion.

Physical Properties. Carbon Steel Studies. Iron Age, vol. 106, no. 23, Dec. 2, 1920, p. 1481. Advance notice of Bureau of Standards Scientific Papers, nos. 396 and 397.

Plasticity. Mechanical Properties of Plastic Materials. Importance of Reactivity (Sur les propriétés mécaniques des corps plastiques. Importance de la réactivité), Henry and François Le Chatelier. Comptes rendus des Séances de l'Academie des Sciences, vol. 171, no. 16, Oct. 18, 1920, pp. 695–699, 3 figs. Re-activity or subpermanent elasticity is termed that property of a material whereby it slowly recovers its original size and shape after a stressing force ceases to operate. Measurements of this property were made on soft steel rods at different temperatures and on a glass rod at 540 deg. cent.

Relation Between Hardness and Grain Size. A Study of the Relation Between the Brinell Hardness and the Grain Size of Annealed Carbon Steels, Henry S. Rawdon and Emilio Jimeno-Gil. Sci. Papers, Bur. of Standards, no. 397, Sept. 20, 1920, pp. 557–593, 25 figs. Brinell hardness of five steels differing considerably in composition and in conditions representing wide variations in grain size was measured to determine relation of this porperty to grain size. Results showed that grain size is a factor of minor importance so far as Brinell hardness is concerned. Structure, which depends upon carbon content, and rate of cooling of specimen after annealing have far greater influence.

Sheet, Thermal Conductivity of. Reducing Temperature of Laminated Cores, T. S. Taylor. Elec. World, vol. 76, no. 24, Dec. 11, 1920, pp. 1159–1162, 3 figs. Experiments at research laboratory of Westinghouse Electric & Manufacturing Co. It was found that transverse thermal conductivity of sheet steel is increased by application of pressure and by varnishing laminations.

Stainless. Stainless Steel, J. H. G. Monypenny. Jl. Soc. Chem. Industry, vol 39, no. 22, Nov. 30, 1920, pp. 390R–391R. Commercial utilization of non-corrodible properties of steel containing about 12 per cent chromium.

Stainless Steel, Its Treatment, Properties and Applications, W. H. Marble. Trans. Am. Soc., for Steel Treating, vol. 1, no. 3, Dec. 1920, pp. 170–177 and (discussion) pp. 178–179, 1 fig. Includes also scaling tests of specimens heated at various temperatures.

Structural. See STRUCTURAL STEEL.

Structure. The Structure of Steel, H. T. Belaiew. Aeronautics, vol. 19, no. 369, Nov. 11, 1920, pp. 347–349. Secondary crystallization. (Concluded.) Paper read before Instn. of Aeronautical Engineers.

Testing. Microconstituents in One Section of a Metcalf Test Bar, Oscar E. Harder. Trans. Am. Soc. for Steel Treating, vol. 1, no. 2, Nov. 1920, pp. 111–116, 12 figs. Photomicrographs.

Vanadium. See VANADIUM STEEL.

STEEL FOUNDING

Cleaning Problems. Steel Foundry Cleaning Problems, A. W. Gregg. Foundry, vol. 48, no. 23, Dec. 1, 1920, pp. 944–945. Methods of flogging, sand-blasting, flame cutting of risers, welding, annealing, sawing risers, chipping, and grinding. Paper read before Am. Foundrymen's Assn.

STEEL, HEAT TREATMENT OF

Electric Furnaces. The Electrical Heat Treatment of Steel, H. P. MacDonald. Trans. Am. Soc. for Steel Treating, vol. 1, no. 3, Dec. 1920, pp. 198–207 and (discussion) pp. 207–208, 12 figs. Records of electric furnace operation.

Electromagnetic Process. Electro-Magnetic Heat Treatment of Carbon Steel, Lancelot W. Wild. Elecn., vol. 85, no. 2217, Nov. 12, 1920, pp. 562–563, 3 figs. Wild-Barfield system of electromagnetic heating for alternating-current working.

Quenching Mediums. The Efficiency of Various Quenching Mediums and Their Application, Victor E. Hillman. Trans. Am. Soc. for Steel Treating, vol. 1, no. 3, Dec. 1920, pp. 161–166 and (discussion) pp. 166–170, 6 figs. Comparative value of animal, vegetable, mineral and compounded oils.

Various Quenching Mediums and Their Application, W. G. Lottes. Trans. Am. Soc. for Steel Treating, vol. 1, no. 3, Dec. 1920, pp. 181–188, 4 figs. Graphs showing cooling rates of water and oil.

Relation to Hardening. Relation of the High-Temperature Treatment of High-Speed Steel to Secondary Hardening and Red Hardness, Howard Scott. Sci. Papers, Bur. of Standards, no. 395, Sept. 16, 1920, pp. 521–536, 18 figs. Attention is called to importance of fundamental research applied to high-speed steel and value of physical tests for this purpose. Effect of heat treatment on density, hardness, microstructure, magnetic properties, and thermal characteristics of standard brand of high-speed steel was determined.

Tractor Worms. Time, Temperature and Heating Media Functions in Hardening Tractor Worms, J. L. McCloud. Trans. Am. Soc. for Steel Treating, vol. 1, no. 2, Nov. 1920, pp. 116–122 and (discussion) pp. 122–126, 12 figs. Practice of Ford Motor Co.

STEEL INDUSTRY

Germany. Germany's Steel Trade Cautions. Iron Trade Rev., vol. 67, no. 22, Nov. 25, 1920, pp. 1476–1478, 1 fig. Analysis of conditions in German iron and steel industry during third quarter of 1920.

South Russia. The Coal, Iron and Steel Industries of South Russia, Arthur W. Richards. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 539–540. Electrical developments.

STEEL MANUFACTURE

Basic Open-Hearth. Working Galvanized Scrap in the Basic Open-Hearth, R. W. Mueller. Iron Age, vol. 106, no. 23, Dec. 2, 1920, pp. 1509. German installation for working galvanized scrap in basic open-hearth furnace, with simultaneous recovery of zinc as zinc oxide.

Electric-Furnace. Electric Steels, C. G. Carlisle. Eng. & Indus. Management, vol. 4, no. 20, Nov. 11, 1920, pp. 618–620. Ability and art of furnace-man in controlling his slags determines whether sound metal is produced or not. Tests show that electric furnace is capable of making excellent nickel-chrome steels; results of series of compression tests are given. Description of an improved exhaust valve.

The Present Position and Prospects of Electric Steel in Great Britain, W. S. Gifford. Elec., vol. 85, no. 2216, Nov. 5, 1920, pp. 528–529, 2 figs. Typical furnace installations.

Ingots. Casting of Steel Ingots, S. W. Williamson. Jl. West of Scotland Iron & Steel Inst., vol. 27, part 8, Apr., session 1919–1920, pp. 94–104 and (discussion) pp. 103–108, 7 figs. on 2 supp. plates. Notes on the four different methods of casting ingots in which attempt is made to fill mold at uniform rate, slow enough to prevent cracked surfaces, namely, the bottom casting, tundish casting, the Fawcett-Batty nozzle, and the magnesite nozzle, each of which is discussed. Two main factors in prevention of length cracks are design of molds and rate of teeming.

Casting of Steel Ingots, S. W. Williamson. Iron & Coal Trades Rev., vol. 101, no. 2751, Nov. 19, 1920, pp. 679–681, 2 figs. Comparative advantages of four methods—(1) bottom casting, (2) tundish casting, (3) Fawcett-Batty nozzle, and (4) magnesite nozzle. (Abstract.) Paper read before West of Scotland Iron & Steel Inst.

Defects in Steel Originating in the Ingot, Austin B. Wilson. Chem. & Metallurgical Eng., vol. 23, no. 24, Dec. 15, 1920, pp. 1161–1166, 22 figs. Microscopic appearance of breaks and inclusions of non-metals in steel, which defects originate during pouring or solidification. Various deoxidizers and their end products are listed and briefly discussed.

Pouring Method. Improving Steel by New Pouring Method, Adolph A. Rackoff. Iron Trade Rev., vol. 67, no. 24, Dec. 9, 1920, pp. 1061–1602, 3 figs. Ladle strainer in which when metal leaves furnace it passes through process of purification, and all light or foreign particles can either be checked from flowing into mold or raked off at top of ladle.

Production Systems. Process and Apparatus for Increasing Production in Steel Manufacture, Adolph A. Rackoff. Blast Furnace & Steel Plant, vol. 8, no. 12, Dec. 1920, pp. 645–651, 7 figs. Difficulties in present open-hearth practice and how they can be overcome with increased production in new process based on better method of pouring steel.

STEEL PLANTS

Canada. New Steel Plant in Western Canada. Commerce Reports, no. 275, Nov. 22, 1920, p. 838. Plant for utilizing scale 40,000 tons of scrap iron formerly exported to United States. Pulverized fuel is used.

France. Messrs. Schneider and Co.'s New Steel Works. Eng., vol. 110, no. 2863, Nov. 12, 1920, pp. 631–634, 6 figs. partly on 2 supp. plates. Description of works at Breuil near Creusot.

Three-Shift vs. Two-Shift Operation. Three Shifts in the Steel Industry. Iron Age, vol. 106, no. 24, Dec. 9, 1920, pp. 1531–1538. Results of investigation covering plants of twenty companies which have adopted eight-hour turn. Questions of increased cost, increased force and increased output. Testimony not uniform on all points, but largely favorable to short day. Paper read at joint meeting of Management and Metropolitan sections of Am.Soc.M.E., New York Section of Am.Inst.Elec. Engrs., and Taylor Society.

Wales. Plaenavon Iron and Steel Works. Iron & Coal Trades Rev., vol. 101, no. 2747, Oct. 22, 1920, pp. 541–544, 20 figs. 15 on pp. 557–560. Smelting plant comprises three blast furnaces with total output of 150,000 tons of pig iron per annum. Details of gas-cleaning plant now being installed, of the Halberg-Beth type, consisting of three standard filter boxes, each having a rated capacity of 1,000,000 cu. ft. per hr. measured at 0 deg. cent.; and steel-making plant, consisting of seven Siemen's acid open-hearth gas-fired furnaces, total output capacity being 120,000 tons.

STRESSES

Determination of. Photo-Elasticity for Engineers—II, E. G. Coker. Gen. Elec. Rev., vol. 23, no. 12, Dec. 1920, pp. 966–973, 14 figs. Results of experimental work on determination of stress in neighborhood of circular hole in tension member, using celluloid models. Theoretical proof that stress distributions are independent of elastic constants of material in many cases is outlined.

Investigation by Polarized Light. Photo Elasticity for Engineers—I, E. G. Coker. Gen. Elec. Rev., vol. 23, no. 11, Nov. 1920, pp. 870–877, 8 figs. Investigation of stresses by means of polarized light transmitted through models of transparent material under stress. Explanation of principles involved in method and exposition of results obtained in practice.

STRIKES

Legal Aspects. The Law in Regard to Strikes, Chesla C. Sherlock. Am. Mach. vol. 53, nos. 24 and 25, Dec. 9 and 16, 1920, pp. 1087–1089 and 1141–1144. Dec. 9: Necessity for enacting of laws, Federal and State, to govern or fix responsibility for strikes and lockouts. Dec. 16: Legal liabilities, responsibilities and duties imposed on employer by reason of strike at his shop or plant.

STRUCTURAL STEEL

Standard Sections. Specifications for Steel Bars, Blooms, and Billets for Other Purposes than the Manufacture of Tools (Cahier des charges pour la fourniture de barres, blooms, billettes et largets au aciers au carbone autres que les aciers à outils. Revue de Métallurgie, vol. 17, no. 9, Sept. 1920, pp. 619–626, 4 figs. Prepared by Commission Permanente de Standardisation.

STUDS

Eccentric-Headed. Making Eccentric-Headed Studs, Frank S. Ward. Am. Mach., vol. 53, no. 24, Dec. 9, 1920, pp. 1083–1084, 4 figs. Method in English munition plant which undertook large contract during war.

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ENGINEERING INDEX (Continued)

T

TEMPERING

Reheating. Tempering and Reheating of Metallurgical Products (La Trempe et le revenu des produits métallurgiques), Léon Guillet. Revue générale des Sciences, vol. 31, nos. 17–18 and 19, Sept. 15–30 and Oct. 15, 1920, pp. 564–581, 34 figs, and 614–620, 5 figs. Influence of different methods of reheating on resulting hardness of alloy steels and bronzes. Diagrams and photomicrographs. Theory of tempering.

TERMINALS, MARINE

Mechanical Handling Equipment. Mechanical Handling Equipment as a Means of Reducing Expensive Terminal Costs, G. F. Nicholson. Freight Handling and Terminal Eng., vol. 6, no. 10, Oct. 1920, pp. 377–384. Type of equipment required. Paper read before Pacific Coast Port Authorities Annual Convention.

TIDAL POWER

Severn Barrage Scheme. The Severn Barrage Scheme. Elecn., vol. 85, no. 2220, Dec. 3, 1920, pp. 659–660, 1 fig. Scheme for utilizing over one-half million horsepower of tidal energy. Designs have been worked out by civil engineering department British Ministry of Transport.

Utilization of. Utilization of the Tides (Utilisation des marées), Amiral Amet. Revue générale de l'Électricité, vol. 8, nos. 16 and 17, Oct. 16 and 23, 1920, pp. 531–542, 11 figs., and 565–575, 9 figs. Scheme for utilizing tidal power at Saint-Malo, France.

TIME STUDY

Small-Part Manufacture. Time Study in Small Part Manufacture, Philip Bernstein. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 401–406. Practical procedure on drilling, profiling, hand and power milling, automatic screw machine and other operations.

TOOLS

Grinding. Grinding Expedites Tool Building, Douglas T. Hamilton. Iron Trade Rev., vol. 67, no. 22, Nov. 25, 1920, pp. 1472–1475, 11 figs. Practice at plant of Fellows Gear Shaper Co., Springfield, Vt.

TRADE UNIONS

Legal Responsibility. Should Trade Unions and Employers' Associations be Made Legally Responsible? Forest R. Black. Nat. Indus. Conference Board, no. 10, June 1920, 35 pp. It is shown that rules of legal liability in theory apply to unincorporated associations in much the same way as to partnerships or corporations, but that as practical matter it is more difficult for plaintiff to conduct litigation and it is particularly difficult to reach funds. This state of affairs is undesirable and special legislation to legalize trade unions is suggested, as it is held that ordinary law of corporations cannot well apply to them.

TRANSPORTATION

Progress in. Education and Training in Transport. Tramway & Ry. World, vol. 48, no. 25, Nov. 18, 1920, pp. 277–280. Progress in transportation and modern civilization. Presidential address before Inst. of Transport.

Rail and Water. The Coördination of Rail and Water Transport, Charles H. Markham. Ry. Age, vol. 69, no. 25, Dec. 17, 1920, pp. 1057–1060. Railways and waterways not naturally competitors and should work together. Railway ownership of boat lines. Paper read before River and Harbor Congress.

V

VANADIUM STEEL

Analysis. Analysis of Vanadium in Steels (Dosage du vanadium dans les aciers), Emile Jaboulay. Revue de Métallurgie, vol. 17, no. 9, Sept. 1920, pp. 627–629. Method consists in dissolving metal in sulphuric acid and transforming vanadium into vanadic acid by action of potassium permanganate.

VIBRATIONS

Machinery. Vibration, Julius Frith. Eng., vol. 110, no. 2863, Nov. 12, 1920, pp. 657–658, 1 fig. Analytical study of vibration, specially that of crankshafts, flywheels and alternating-current generators.

W

WAGES

Minimum. Legal Minimum Wages, Douglas Knoop. Discovery, no. 12, Dec. 1920, pp. 364–368. Advocates fixing legal minimum wages in each trade by establishing Trade Board for that trade, consisting of members representing employers and employees in equal numbers and of three independent persons, preferably professional men and women.

Rates. Should the State Interfere in the Determination of Wage Rates? Harleight H. Hartman. Nat. Indus. Conference Board, no. 12, Aug. 1920, 158 pp. State interference is said to be expedient because it prevents actual pecuniary loss to employer, employee and public, and because it places industrial disputes upon a basis of substantial justice rather than force.

Reduction. What Are You Doing About Wages? Neil M. Clark. Factory, vol. 25, no. 12, Dec. 15, 1920, pp. 1869–1874. Opinions of manufacturers and leaders of labor unions in regard to advisability of reducing present standard of wages.

What Will Employers Do About Wages? Don F. Kennedy. Iron Age, vol. 106, no. 24, Dec. 9, 1920, pp. 1543–1544. Plea for frankness in dealing with employees.

Wage-Incentive Systems. The Bases of Emerson Incentive, Harrington Emerson. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 413–416. Comparison of wage-incentive systems.

Common Labor Responds to Incentives, J. D. Town. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 422–424. Satisfactory results of introducing bonus system in foundry.

WATER POWER

Development in U. S. Development of National Water-Power Resources, C. D. Wagoner. Eng. World, vol. 17, no. 6, Dec. 1920, pp. 439–441, 3 figs. Statistics of developed and undeveloped water-power in United States.

France. Harnessing the Rhône River by Deviating Its Course (Nouveau project d'aménagement du Haut-Rhône par dérivation), Genie Civil, Sept. 25, 1920, pp. 250–255, 3 figs. To better utilize hydraulic energy of Rhône where river course follows nearly circular path, it is proposed to construct tunnel between extremities of arc. Economies of such project and of another involving construction of dams at points in circular course of river are compared.

The Harnessing of the Rhône (L'aménagement du Rhône), J. Tribot-Laspière. Technique Moderne, vol. 12, no. 4, April 1920, pp. 151–154, 1 fig. Details of project adopted by French Chamber of Deputies, and its economical advantages.

Hydrographic Study and Harnessing of the Toce-Devero Basin (Étude hydrographique et aménagement du bassin Toce-Devero), G. Malgorn. Electricien, vol. 36, no. 1263, Nov. 1, 1920, pp. 457–461, 6 figs. Economic advantages of utilization of water power of region. (Concluded.)

Germany. Hydro-Electric Power in Germany. E. Sympher. Elecn., vol. 85, no. 2218, Nov. 19, 1920, p. 590. Deals with nationalization of electrical industry, which was legally enacted Dec. 31, 1919 and describes new schemes, including the Rhine-Danube canal and the Moselle-Saar canals. Abstract from Elektrotechnische Zeit. of paper read before Instn. German Elec. Engrs.

The Unlimited Utilization of German Water Power a Present-Day Necessity (Die restlose Erfassung unserer Wasserkräfte, ein Gebot der Gegenwart), W. Halbfass. Elektrotechnische Zeit., vol. 41, no. 40, Oct. 7, 1920, pp. 792–794. Points out that the water power of German rivers can be better and more completely utilized when their development is effected not simply by means of ordinary gradient-section works, but in connection with dams. Writer recommends, besides the construction of large water-power plants, that of small plants which require much less expenditure and serve many useful purposes, a special field for their use being the utilization of so-called water-power wastes.

Great Britain. Water-Power Resources and Projects in United Kingdom, Robert P. Skinner. Commerce Reports, no. 287, Dec. 7, 1920, pp. 1051–1053. Water-power resources committee of British Board of Trade recommends that controlling water commission be established by act of Parliament.

Niagara Falls. Niagara's Mighty Power will Breed Lively Fight. Water Power, vol. 1, no. 5, Nov. 1920, pp. 10–12, 2 figs. Rival applicants for right to use flow of cataract after filing applications with Federal Power Commission. Schemes contemplated are discussed.

St. John River, Canada. Storage and Power Possibilities on St. John River, A. Langlois. Contract. Rec., vol. 34, no. 49, Dec. 8, 1920, pp. 1169–1170, 1 fig. Regulation of flow at reversible falls to improve navigation and permit development of power.

WAVES

Elastic Solids, Speed in. Speed of Waves in Elastic Solids (Sur la célérité des ondes dans les solides élastiques), E. Jouguet. Comptes rendus des séances de l'Académie des Sciences, vol. 171, no. 11, Sept. 13, 1920, pp. 512–515. Formulas.

WELDING

Electric. See ELECTRIC WELDING.

Oxy-Acetylene. See OXY-AXCETYLENE WELDING.

WELDS

Testing. Study of the Testing of Welds, S. W. Miller. Blast Furnace & Steel Plant, vol. 8, no. 12, Dec. 1920, pp. 678–683, 26 figs. Bend test. Microscopic and macroscopic study of welds. Paper read before Am. Welding Soc.

The Testing of Welds in Steel Plants, S. W. Miller. Ry. Mech. Engr., vol. 94, no. 12, Dec. 1920, pp. 792–794, 9 figs. Conditions which affect quality of welds; simple bend test and etching of sections recommended. Paper before Am. Welding Soc.

WELFARE WORK

Industrial Hygiene. Economic Aspect of Industrial Hygiene, Bernard J. Newman. Indus. Management, vol. 60, no. 4, Oct. 1920, pp. 271–273. Relation between health and general welfare of employees and their working efficiency.

Restaurants. A Centralized Organization for Feeding Men, Hunter McDonald. Ry. Maintenance Engr., vol. 16, no. 12, Dec. 1920, pp. 469–472, 11 figs. Plan in use by Nashville, Chattanooga & St. Louis Railway. Paper read before Am. Ry. Bridge & Building Assn.

Solves Problem of Feeding Army of Workers. Iron Age, vol. 106, no. 24, Dec. 1920, pp. 1527–1530, 9 figs. Dining room at East Pittsburgh works of Westinghouse Electric & Mfg. Co., where 50,000 persons are employed.

Savings Association. Our Savings Association as an Aid to Management, C. L. Walker. Factory, vol. 25, no. 11, Dec. 1, 1920, pp. 1715–1718, 5 figs. Experience of A. W. Shaw Co.

Savings Plan. How One Community Has Succeeded in Getting Employees to Save, John F. Tinsley. Factory, vol. 25, no. 12, Dec. 15, 1920, pp. 1899–1901, 4 figs. Plan employed at Worcester Works in Massachusetts.

Sick Leave With Pay. A Plan for Sick Leave With Pay, Morris R. Machol. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 453–454. Method is based on length of time employee has been in service of company.

Welfare Department. Is "Welfare Work" Accomplishing Constructive Results? Norman G. Shidle. Automotive Industries, vol. 43, no. 13, Sept. 23, 1920, pp. 619–621. Suggests auditing "welfare" department and making it justify its existence just as definitely as in production department.

WHEELS

Cast-Iron, Grinding. Grinding Cast Iron Wheels. Ry. and Locomotive Eng., vol. 33, no. 12, Dec. 1920, pp. 345–349, 2 figs. Machine for grinding wheels. Tables showing data of measurements of slid flat wheels.

WIND MOTORS

Efficiency of. Wind-Driven Airscrews (Ueber vom Windegetriebene Luftschrauben), M. Munk. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 15, Aug. 15, 1920, pp. 220–232, 1 fig. Determination of the efficiency of the wind wheel, and discussion of the aspects governing proportion of vanes.

Theory of. Theory of the Ideal Wind-Power Machine (Theorie der idealen Windkraftmaschine), Wilhelm Hoff. Zeitschrift fur Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 15, Aug. 15, 1920, pp. 223–227, 8 figs. Develops relation between air propellers and windmills and shows that the theory of the ideal jet motion is applicable to the ideal wind power machine. Supplement to article by M. Munk in same issue of journal.

WIND POWER

Utilization of. The Maximum Theoretically Possible Utilization of Wind through Wind Motors (Das Maximum der theoretisch möglichen Ausnützung des Windes durch Windmotoren), A. Betz. Zeit. für das gesamte Turbinenwesen, vol. 17, no. 26, Sept. 20, 1920, pp. 307–309. Equations are derived for calculation of the maximum amount of energy which can be produced with a windmill of a given diameter operating without loss.

The Study and Design of Wind-Power Plant (Beitrag zur Kenntnis und zum Entwerfen von Windkraftanlagen), M. Mayersohn. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 45, Nov. 6, 1920, pp. 925–931, 14 figs. Abstract of treatise approved by machine-construction department of Berlin Technical Academy on wind-power plants and their usefulness in Palestine, discussing practical types of wind motors and recording operating experiences with different plants. Suggestions for planning wind-power plants are made.

The Utilization of Wind Power for the Generation of Electricity (Udnyttelse af Vindkraften til Fremstilling af Slektricitet), E. Adler. Ingenioren, vol. 29, no. 78, Sept. 29, 1920, pp. 595–598, 3 figs. Points out that Denmark is far in advance of other countries in utilization of wind power, partly because of its climate and partly because of work of Professor La Cour. One difficulty is said to be that generators of windmills, because of the storage, must deliver direct current, whereas country's system is equipped for alternating current, as remedy for which, writer recommends the coupling of wind mill with an induction generator.

Wind Turbines (Les turbines a vent), E. Weiss. Nature (Paris) no. 2429, Oct. 23, 1920, pp. 257–259, 7 figs. Escaffre wind turbine at Paris fair.

WIND TUNNELS

German. Report on German Wind Tunnels and Apparatus, Edward P. Warner. Aerial Age, vol. 12, no. 11, Nov. 22, 1920, p. 298. Zeppelin wind tunnel at Friedrichshafen. (Concluded.)

WIRE MANUFACTURE

Processes. Modern Process of Drawing Wire, L. Dwight Granger. Blast Furnace & Steel Plant, vol. 8, no. 12, Dec. 1920, pp. 661–663. Practical application surrounded by great many technical considerations with reference to speed of wire through dies. Annealing and composition of material.

WOMEN WORKERS

Advisability. The New Place of Women in Industry—III, Ida M. Tarbell. Indus. Managment, vol. 60, no. 6, Dec. 1920, pp. 399–400. Management of women workers.

WOOD

Treatment of. Treatment, Seasoning and Fireproofing of Industrial Wood (Imprégnation, sénilisation et ignifugation des bois d'industrie), J. Escard. Houille Blanche, vol. 19, no. 43–44, July-Aug. 1920, pp. 148–151. Chemical compounds used for treating. (Continuation of serial.)